

THE VELIGER

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WELCOME!

It is in the nature of the shell collector to search out new haunts for discovery of new specimens.

Though the reward--here, during the Pacific Division Annual Meeting--may not be in the hand, we trust that your mind and your spirit shall be as satisfyingly refreshed.

The Northern California Malacozoological Club and the Sacramento Conchological Club--co-sponsors of the convention--tell you "Hello" and welcome. We hope that the awaiting events of related interests, and fraternal "finds" in new acquaintances will be of memorable pleasure.
HAVE FUN.

"THE VELIGER"

Our quarterly publication, "THE VELIGER", has a most aptly chosen name. The veliger is a characteristic larval stage of many mollusks and is not found in any other group of animals. What, then, could be more appropriate than "THE VELIGER" as an emblem for our club; for, in a sense, are we not also an embryonic group, aiming toward some individual mark of distinction?

Having selected "THE VELIGER", let's get better acquainted with it. The name of the larval stage is derived from the fact that the embryo possesses two, four, six or even eight so-called veils (velum), which are organs of locomotion. The vela (plural)

are provided with cilia which beat and propel the animal through the water. As a note of interest, the veliger pictured on our masthead is that of a slipper shell of the genus Crepidula.

Here's to our publication, "THE VELIGER"! Here's to its steady growth, and to a progressive source of information and pleasurable reading from and for all of us.

EARLY HISTORY OF N.C.M.C.

The chance meeting of Lucille Zellers, Helen Burton and Ralph O. Fox led to their attendance at an AMU meeting at Mills College, Oakland, with the resulting desire to form a Shell Club.

An organizational meeting was held at the home of Helen Burton on February 13, 1952. Charter members were Betty Babbitt, Helen Burton, Dr. and Mrs. E. V. Edmonds, William K. Emerson, Ralph O. Fox, Colonel and Mrs. Lee Miles, Margaret Oehlman, Marianna Paulson, Allyn G. Smith, Dr. Rudolf Stohler and Lucille Zellers.

This group, acting as a committee, discussed name of club, day, time and place to meet, amount of dues per member and program. An attempt was made to include all persons interested in mollusks, from the beauty of shells to the animals living within; thus the name, Northern California Malacozoological Club, was chosen. Meetings were to be held the first Tuesday of each month, from 8 to 10 P.M. and membership dues, per calendar year, to be \$1.

A second meeting was held at the home of Lucille Zellers on March 4, 1952, at which time final plans were made to become an active club. Officers elected were Ralph O. Fox, president, Helen Burton, vice-president, Lucille Zellers, secretary-treasurer.

On April 1, 1952, the first official meeting was held at the Oakland Public Museum, which had been selected by the committee as the most convenient place. As a result of newspaper articles and personal contacts a large group assembled, with several new names being added to the membership list.

After a time the Museum quarters were found to be inadequate. It was suggested that the Club move to the University where the facilities for study were greater. Accordingly, sanction was obtained from University officials for the Club to meet in the Life Sciences Building, U.C. Campus. Meetings have been held there ever since March 3, 1956.

Lucille Zellers

EMBRYO MALACOLOGISTS

"From little acorns great oak trees grow" is the adage which prompted Mrs. Marianna Paulson, a charter member of the Northern California Malacozoological Club and an elementary school teacher, to organize the Fairmont School Junior Conchology Club in El Cerrito, October 1955.

This club proved to be very popular with the "young fry", even though they met every other Wednesday morning from eight to nine. Each year there has been a membership of at least fifty, but this year it reached an all high of ninety-five. Due to the large number, the group was divided into sections, "The Beginner's Club" from second and third grades, and the "older Club" from fourth through sixth grades.

Highlights of the club's meetings were talks given by our adult club members, Helen Burton, Lucille Zellers and Gladys Archerd. A conducted tour of the Junior Conchologists through the University of California's Paleontology Museum was also included in the activities of the first year. Ned Allison gave the youngsters a very informative talk, with explanations of the Museum specimens.

The club's second-year highlight was a "field trip" to view Helen Burton's and Lucille Zeller's Shell collections.

The children conduct their meetings in a businesslike manner and usually feel that the hour has disappeared too quickly. The minutes of the previous meeting are read, the roll is called, old and new business discussed, after which comes the sharing of shell experiences and newly acquired specimens. Mrs. Paulson has tried to acquaint the children with shell terms and the chief characteristics of one

different shell family at each meeting.

Window shell, Cowrie, Sea Urchin, Sand Dollar, Starfish, Conch, Murex, Abalone, Limpet, Patella, Cassis, Cone, Pen and Tun are the families that have been discussed this year, with a specimen on display of the particular shell being studied. Both the common and the scientific name of each specimen was given.

The parents have been most cooperative and appreciative and purchased books on sea shells for their children as well as giving them occasional shell-collecting trips. In the terms of one mother, "In order to live peacefully with our daughter we simply had to go to a beach to collect shells. Another mother said she felt that the table had turned and, instead of she instructing her children, they were teaching her many things about sea shells.

No doubt some of our tomorrow's shell collectors and real malacologists will sprout from this nucleus.

A DREAM COME TRUE

All collectors, I am sure, dream of collecting some day on the Great Barrier Reef of Australia. This dream came true for me when my sister and I sailed on a freighter in September, 1957, for Sydney.

As Spring was fairly well advanced and because the Great Barrier Reef, which stretches 1200 miles along the Coast of Queensland, is in the tropics, we immediately flew to Cairns where we were met by Mrs. B. Clark, with whom I had exchanged shells, and she introduced us to her collector friends and coral reef collecting.

We left Cairns by boat for Green Island, one of many true coral islands, which have been built over the ages on coral reefs by debris and dead coral

thrown up by storms, sprouting vegetation and trees from seeds brought by waves, winds and birds. These islands are rarely more than sixteen feet high. Later we were to visit continental islands, some over 2,000 Ft. high which, aeons ago, had been part of the mainland but, due to the sinking of the coast line, now form the famed islands of the Whitsunday and Long Passages.

At Green Island we had our first big thrill when we visited the newly installed "Under Sea Laboratory," where we could see through portholes in a sunken room, corals of all kinds and of exquisite colors.

What excited us most was the giant clam, so close that we could have touched it had the glass not been there. Three feet across and open nearly a foot, it displayed its velvety-looking purple mantle, which extended like a wide ruffle over the curving edges of the lips of the shell. Its siphon, as big as a fire hose, was pumping in water with a slow pulsating movement. The colors of the mantles of these tridacnas, which we were to see later, are those of the algae, purple, green, blue or yellow, which live within the mantle, aiding the clam in securing more oxygen for its needs.

Our first time out on the reef was a thrilling adventure. Armed with reefing sticks to help us keep our balance and wearing knee length knitted sox to protect us against scratches, we waded out to where the water was cascading off the reef into the ocean. Our hopes ran high and we were not disappointed. That day we found Strombus luhuanus by the hundreds; Pterocera lambis, gorgeously colored as one seldom sees them in collections due to rapid fading; 2 Volute rutila; huge Cerithium contumax nodulosus, four to five inches long; 1 Conus geographicus; 1 Conus marmoreus; cobalt blue star fish, startlingly brilliant; sea urchins with needle-like spines eight inches long.

We stopped next at South Molle, a continental island, where we explored the outer reef. At first glance it was rather disappointing, mostly yellows and browns, but the brilliant colors were there, only in smaller patches. We were successful in finding Turbos; Trochus; Astraeas; common Cypraea arabica; C. linx; C. erosaria erosa and others.

"Turtle Hunting" at night on Heron Island, the best known of the Capricorn Group at the southern end of the Great Barrier Reef, was a unique experience. We watched the 400-500 lb. green turtles lumber laboriously up the beaches to well above high tide. Throwing the sand behind them with their powerful flippers, they dug holes 18-24 inches deep. Then they skillfully scooped out a second hole with their hind flippers and into these holes they dropped from 120-150 leathery eggs, the size and shape of golf balls, after which they completely filled the large cavity and then dug another as a camouflage.

It was here that I acquired Heron Island Voluta cymbiola pulchra and from Wilson Island I obtained most of my forty-two species of Cypraea.

We then left Queensland for New South Wales, terrain of quite a different character. Here on Long Reef, not a coral formation but a rocky headland, we found quantities of heavy shells; Cymatrida mayena australis; Charonia rubicunda; Dicathais orbita; Turbo torquata and many more.

On the sand flats at the mouth of the George River were thousands of Cerithium pyrazus ebeninus; Natica uber conicum and N. uber strangei. Most of the Pecten notovola fumata were so loaded with jingle shells, often six to eight, that they were really immobilized.

And so with my 200 lbs. of treasures shipped home to clean and classify one can see that I have greatly enriched

my collection and have made my dream come true.

Helen Burton

ON THE LIGHTER SIDE

Mr. and Mrs. Phil Bancroft have been hosts at their Walnut Creek home for our annual Christmas party the last two years.

This past Christmas Ruth received a unique gift from Phil and, in the following excerpts from a letter of hers, she describes what may, in part, have given him his inspiration.

"You may have heard that Phil built me a cupboard for my shells. When I opened it I found walnuts on one shelf. Another had pecans, another peanuts, etc. Another had small gun shells, another medium-sized ones and others had various sizes. One had shell maps, another egg shells. And finally this poem was on the bottom.

"He is always telling me that I should throw back anything under an inch long, which includes almost everything I have found. When he went on a hunting trip to Alaska a few years ago, he got something big enough to be worth while - a brown bear.

"On both of our trips south, while I would be looking hard for shells, he would sit on a rock and relax and wait. Then he would pick a giant keyhole limpet off an adjoining rock and say casually, 'Is this what you are looking for?' Our score is still Phil 2 - me 0."

The Beachcombing Bride
or

My Malacozoological Maid

O some go down to the sea in ships
To sail the seven seas,
And some admire the crashing surf
And the feel of a fresh salt breeze.
Some are lured by the wild romance
Of the monsters of the deep,

And some go down and work like slaves
To earn their board and keep.
Some are fond of the mighty surge
As the ocean ebbs and swells
But my true love has eyes for naught
But unobtrusive shells.

O some will cross the Arctic ice
To hunt for Urs Polaris,
And some will go to Kodiak
(That is where the big brown bear is)
Some will trek the jungles dense
To take the fierce Rhino,
And some will travel to Timbuktu
To snare the damdifino
O some will hunt throughout the veldt
In search of the giant tusker,
But my love will hunt on any old shore
For a phylum called Mollusca.

You can talk at length of the Lion's
strength
Or the tremendous size of the Tiger.
You can spin tall tales of the great
Blue Whales
Or the Hippos from the Niger.
The giant squid and the things he did
Provide an endless topic,
But my adored comes home with a hoard
Of trophies microscopic.

Though storms may prevail that make
Other folks quail
And hardy seamen frighten,
She exhibits no grief, climbing over a
reef

Pursuing a snail or chiton.
Neither cold, nor heat, nor the time
she should eat
Deters my love in her searchin'.
She examines each pool, and then as a
rule
She extracts a cone or urchin.
If the tide be but low, on her quest
she will go;
There's naught can make her skimp it.
And she'll hunt through the haze 'til
the end of her days
For a giant keyhole limpet.

here than anywhere else in the world.
These are called limpets, or scientific-
ally, Acmaea. There are about twenty
species of Acmaea. Another group, al-
so called limpets, are not true limpets
but Fissurellidae; these are commonly
called keyhole limpets.

Both groups live in similar en-
vironments, on rocks, sea plants, and
also on other mollusks. Some are very
common, some quite rare. They are not
carnivorous, but are vegetarians,
scraping food off rocks with a toothed
tongue called a radula. They feed
chiefly at night, moving slowly from
place to place, and spend days making
themselves as inconspicuous as pos-
sible, preferably in shade. When
disturbed, they clamp themselves so
tightly to the rocks that it is esti-
mated it would require a 70-pound pull
to remove them. Sexes are separate,
with eggs laid in some cases in gelati-
nous strings or masses. In order to
live they need shade, moisture and
food in that order of importance.

I have been able to accumulate
about twenty-eight of the thirty vari-
eties of limpets. These are accurate-
ly described in most of our reference
books. Here I would like to describe
groupings according to living condi-
tions.

In the early 19th century Dr.
Eschscholtz, a German accompanying a
Russian exploration party, did research
from Fort Ross to Monterey. He named
five of our most common limpets:
Acmaea mitra, A. pelta, A. digitalis,
A. persona and A. scutum.

The first group of limpets live
high on rocks in the splash zone.
These are Acmaea scabra, A. persona,
A. digitalis, A. pelta, Lottia gigantea
and Acmaea conus, from the south. A.
digitalis is the most common and it
can stand more pollution than any of
the others. Lottia gigantea, our
largest limpet, ranges far afield for
its food, but it always returns to its
original scarred place on the same
rock.

WEST COAST LIMPETS ACMAEA AND FISSURELLIDAE

On our West Coast we have famil-
ies of mollusks that are more abundant

The next group are the limpets that live on sea plants: Acmaea depicta, A. paleacea and A. triangularis, the first two of which live on eel grass in protected bays and estuaries, and A. insessa and A. instabilis which live attached to the fronds and stems of a certain type of kelp. The entire group have smooth and fragile shells due to the environment.

The next two limpets are rather similar and, at one time, were thought to be the same species. These are Acmaea limatula and A. scutum. Both are round and flat. A. scutum is found further north and A. limatula is more common in the south. Scientists have found that the animals are quite different, but both live in the intertidal zone on exposed rocks.

A few rugged individualists like Acmaea mitra live below tide level on rocks. This limpet is taller and heavier than any other limpet and is often covered with corraline algae. Another individualist is A. fenestrata cribraria. It is the only limpet that lives on loose, bare boulders set in sand, and feeds submerged.

The little, black Acmaea asmi lives mainly on another mollusk, Tegula funebris.

Two rare limpets are Acmaea rosacea and A. ochracea. A. ochracea is found in deep tide pools, chiefly south of Monterey. A. rosacea is a small, fragile limpet found south of Santa Barbara. I was unable to find references pertaining to either one.

The keyhole limpets, belonging to the family Fissurellidae, live in similar surroundings. Megathura crenulata, our giant keyhole limpet, is dredged from deep water. Megatebennus bimaculatus is a tiny one living in the intertidal zone in rock crevices. Both have huge bodies in comparison to the size of the shells, which sit like caps on top of their bodies, and are usually covered almost completely by the mantle.

Diodora aspera, our rough keyhole limpet, D. murina, the white keyhole limpet, and Fisurella volcano, the volcano limpet, are all common on rocks in the intertidal zone.

Puncturella cucullata and P. galeata are dredged from sand and mud in the southern part of the state. P. cucullata is found in the intertidal zone in Alaska.

Lucapinella callomarginata is found under rocks from Bodega Bay south.

Hematoma bella is an extremely rare mollusk from deep water. The few known live specimens taken have been dredged.

Gladys D. Archerd

PERSONALS

Mr. and Mrs. Herbert Bendheim left on April 1 for a tour of Europe. Rotterdam was the first port of arrival. In Paris they hired a Renault, enabling them to visit most of the capitals of Europe by the middle of August, their sailing date for home.

Hazel Jeschien was the guest speaker at a recent meeting of the Good Fellowship Club at the Berkeley Y.W.C.A. Her topic was "Shells from Many Lands," which she illustrated with specimens from Africa, Italy, Japan and Hawaii.

On June 11th Dee Smith will leave San Francisco for a three months trip to Europe, flying over the Polar route to London. From there a Volkswagen will take her to the Scandinavian countries, the Fair at Brussels, Germany, France, Italy and Spain.

Ned Allison will join a party from Scripps Oceanography Institution to collect on Clipperton Island (700 miles southwest of Acapulco, Mexico) during the month of August.

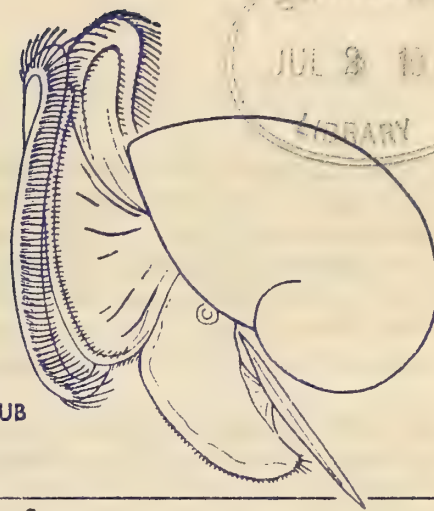
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Volume 1

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No. 2

CONVENTION EPILOGUE

The last day of the AMUPD convention (6/29/58) was crowded with surprise and satisfaction for most of us. Arranged for our viewing at the Hearst Mining Building on the UC Campus was a display of many rare shells of considerable wonder and beauty, with locale and zonal designation outlined on large charts. For this private showing, the time invested in its preparation, and for his personal leadership in this trip for us, we are most grateful to Ned Allison.

Following this, at 10:30 A.M., a fossil hunt was organized under the expert guidance of Dr. George Kanakoff of the Paleontology Museum at L.A. This trip took us to Selby, Torme, Pecten Point and Rodeo. It was an exciting, successful adventure, shared with Sacramento and Los Angeles convention guests, and highlighted by the presence of Anne Brown (L. A.) and Neil Marshall (Berkeley), two youngsters whose enthusiasm and spontaneity gave added zest to the hunt.

We gathered fossil clams, snails, pecten, cockles and sand dollars; even hammering some off a hill on a residential street. We were so contentedly occupied that it was dinner hour before we realized that we had missed lunch. Though we looked the color of the hills we had scaled for

fossils, we entered a restaurant in Rodeo, en masse, enjoying yet another chance to become better acquainted as we compared our finds.

To Dr. George Kanakoff, our thanks for sharing his know-how so generously. And how we DO envy him his agility in going up and down those hills!

Kris Rosman

By reason of his "back-stage" activities during the AMUPD convention, so timely and efficient, our Vice-President, Ned Allison, won another well-earned title, viz: "Our Man Friday."

As the local member of the AMUPD we join our appreciation with that expressed by Dr. Harris to the officials of the University of California for the gracious hospitality extended to our organization during its recent convention.

The use of lecture rooms, registration tables, the Sunday opening of the Paleontology Department and other courtesies gave fitting background and added greatly to the convenience and enjoyment of this scientific group.

Of the ninety-four registrations Dr. William K. Emerson, formerly of the Paleontology Dept. of UC, now with the American Museum of Natural History in New York, was the only one from the East Coast. Our own club was represented by the following:

Ned Allison, Gladys Archerd, Phoebe Balch, Ruth Bancroft, Helen Burton, Mary Handley, Mr. & Mrs. Virgil Herring, Merton Hinshaw, Helen Hunt, Hazel Jeschien, Eleanor Korver, Dr. Phyllis Kutsky, Mr. & Mrs. Douglas Larson, Neil Marshall, Mrs. Muriel Olson, Marianna Paulson, Mr. & Mrs. Jos. Rosman, Frank Russ, John Saxby, Allyn Smith, Evelyn Wilson, Lucille Zellers.

To those members who weren't present at the convention: you missed some very fine papers, also pictures. Dr. Mead's recent pictures of Bangkok and surrounding country were shown at the banquet and were of great beauty and interest. As these pictures were being shown Dr. Mead's rapid-fire talk gave his audience a wide comprehension of the pleasures and difficulties of this trip.

The wall and table decorations by Hazel Jeschien for the convention banquet displayed not only artistry, but great patience and much work. At each place was a tiny garden in the lower valve of a small clam shell, with the upper valve forming a canopy. Larger gardens on the tables were in abalone shells and those people seated in lucky chairs received one of these also.

The following graciously consented to display shells prior to and during the recent convention of the AMUPD here in Berkeley:

Berkeley Public Library; Hink's; Pittsburgh Plate Glass Co.; National Audubon Society; Dr. Thal, optometrist; Breuner's in Oakland. The Fuller Paint Co. kindly loaned a mirror to enhance Hazel Jeschien's display.

The Club is most grateful to Reginald Machado for the excellent placards he gave us and which have been distributed in strategic places to inform the public of a cultural group, whose meetings are open to all who may be interested in shells.

That they are accomplishing their objective is attested by many of our new members, who were first attracted by the interesting and unusual design of the placard.

MARINE ALGAE or SEaweEDS

There seems to be no popular literature on this subject, so one must turn to textbooks of botany or other scientific publications which discourage the reader whose interest is not geared to that intensive coverage. Perhaps the future will produce a popular booklet which will further open the doors to this fascinating group of the plant kingdom.

Algae are a part of that vast population of vegetation known as non-flowering plants. In all these, reproduction is not with blossoms as in the flowering plants, but by male and female cells produced in or on the body of the plant and released into the water. In some cases this is very complex, and in others very simple.

(continued)

Algae vary in size from microscopic one-celled plants to giants of 80 to 100 feet in length, like the large "ropes with the knob" we find so commonly on our beaches. They occur in sea water, fresh water, on land, upon other plants and some are air-borne.

It is the marine forms of our sea-coast in which we are most interested for the present. I dare say, most of us are unaware that our Central California coast is far richer with this form of life than any other portion of the United States' west coast. About 80% of the species found from the Canadian line to the Mexican border are represented here.

Is it any wonder then, that as early as 1792, an English botanist, Dr. Archibald Menzies, spent several months gathering specimens and data in Monterey Bay? It is interesting to note that following that early date, the algae of the then relatively inaccessible and practically uninhabited coast of California were studied before those of the more accessible and the more populated Atlantic coast.

The marine algae live in all the varying situations presented by our versatile coast line. Many of them appear rather "indifferent" to their surroundings; others very "choosy." The Sea Palm is found only on prominent rocks in the midst of pounding surf; another one of smaller size is found only on the base of that palm. Others are so particular as to be found in somewhat more protected and warmer spots like Stillwater Cove at Pebble Beach.

If some day at the seashore you will observe the whole plant, you will note that a root system is lacking. There is, however, a specialized clump at the base of the plant--this is a holdfast. It serves to hold the plant to the rocks, to the wharf, or sometimes to another plant. Because shifting sandy beaches offer poor foundation, few algae live there.

The root system so necessary in the land plants, which get their food through the roots from the soil, is not necessary in these plants whose body is entirely bathed in the nutrient solution--the sea water. The food is absorbed directly into the body of the plant.

Also you will note, there are no leaves or stems as we know them in land plants. These plants are very primitive and in the process of evolution have not reached such a level of development. However, many of them have developed air sacs, or floats, which provide the buoyancy needed to keep the plants upright in the water and nearer the surface where sunlight is strongest.

As regards the component chemicals and minerals in solution in sea water, here, too, is a variation in the demands of different species. Those high on the rocks are long exposed to sunlight and drying at low tide, while lower down crowd the forms that can survive only short intervals of exposure at lowest low tide.

Merton E. Hinshaw

To be continued.

LIVE COLLECTED
and

SEMI-FOSSIL DREDGED CYPRAEA

Much confusion exists, even today, in the Conchological world due to the use of the terminology "dredged shells." This is further aggravated by lack of experience with semi-fossils and knowledge concerning them.

The usual collector without experience with semi-fossils always thinks of a dredged shell as one collected alive by a collector dredging from a boat. Normally this trend of thought is correct; however, semi-fossils are also collected which are brought up by large dredges deepening or widening harbors or channels. (continued)

Some of these semi-fossils are perfectly preserved, having been buried in a loose calcareous matrix, retaining their gloss and in fine condition. In fact, some are so well preserved that they appear to be live collected, with the exception of the color which has faded to a beautiful pellucid golden yellow. In some species a reduced coloration of a different hue occurs. The preservation of their gloss is due to the absence of all corroding agents such as acids, fungus, etc. The actinic rays of the sun may have penetrated through water and the calcareous deposit within which the shell is buried and has faded the shell.

It is perfectly logical that a collector, who has no knowledge of semi-fossils, on receiving a fine shell with data slip reading, for example, "dredged in Honolulu Harbor" will assume it is live collected. It is quite difficult to tell the difference between a perfectly preserved semi-fossil and a live collected shell.

Shells other than Cypraea, such as Mitra, Terebra, etc., are preserved in the same manner as Cypraea.

These semi-fossils or sub-fossils have been buried, in some cases, for several hundred years and are in the early stages of becoming fossilized.

I have had experience with semi-fossils from dredgings at Honolulu and on Kwajalein atoll in the Marshall Island group. My knowledge has been further increased by listening to the experiences of Prof. Ostergaard and Mr. Ditler Thaanum of Honolulu. Both of these gentlemen were collecting shells when I was born and collected and studied many semi-fossil shells from Honolulu Harbor during the extensive dredging operations in 1905 and 1915.

In only one instance have I seen color forms in the living shell like those of semi-fossils. It was a Conus.

Ray Summers

STUDY GROUPS

When a large number of malacozoologists get together as in our Northern California Club, the stimulation of discussion frequently leads to a desire to pursue in round-the-table size study groups subjects of special interest which cannot be conveniently handled in a general meeting. Some members are interested in studying shells of a particular family, or shells of a certain area, or in gaining facility in classifying their collections. A study group can bring real enjoyment to the participants and perhaps yield results which will be helpful to other malacozoologists.

When some such interest develops in west coast forms we are fortunate in having available the mollusk study collection of the Zoology Department of the University of California, through the courtesy of Dr. Rudolf Stohler. Some time ago with Dr. Stohler's help a group of us, including Gladys Archerd, Phoebe Balch and Frank Miller, undertook an intensive study of the genus Tegula, as represented on the California coast by T. aureotincta (FORBES), T. brunnea (PHILIPPI), T. funebris (A. ADAMS), T. gallina (FORBES), T. ligulata (MENKE), T. mariana (DALL), T. montereyi (KIENER), T. pulligo (GMELIN), T. regina (STEARNS) and T. rugosa (A. ADAMS).

For the most part these turban shells are not things of beauty. Within our readily accessible collecting areas, one would hardly look twice at T. brunnea or T. funebris for they are usually the most abundant snails on the reefs. However, when one has a collection of turban shells from up and down the coast it is a fascinating task to study their similarities and differences in an effort to distinguish one from another with accuracy. There is no published key to assist.

After examining specimens of the ten species we set as our goal preparation of a workable key to the California coast Tegula, adult and
(continued)

juvenile. Our work in bimonthly meetings progressed well until a sparcity of specimens of T. rugosa and T. mariana caused a temporary halt. This deficiency has been remedied and we hope soon to complete the key. Then perhaps we can have one of our general meeting keying sessions devoted to Tegula to test the results of one study group project.

Phyllis B. Kutsky

RULING BY INTERNATIONAL COMMITTEE ON NOMENCLATURE

A few months ago the International Committee on Nomenclature, after many years of careful consideration, rendered a decision which affects shell collectors on the Pacific Coast. This decision rules that all the names given to shells by Martyn in 1784-1786 are invalid as his publication does not conform to the basic requirements of the international rules. (We may, in future issues of the Veliger, attempt to explain some of the basic rules affecting scientific names of animals.) Fortunately for us, many of these fairly common species named by Martyn were discussed by other writers within a few years after their original description and under the names they were first given. Thus quite a few have become "validated," which means that the name of the shell remains unchanged but the "author" name is changed. The list following this paragraph will give the "old" and the "new" names in parallel columns:

Astrea inaequalis (Martyn).....
.....Astrea gibberosa (Dillwyn)
Calliostoma annulatum (Martyn).....
.....Calliostoma annulatum (Humphrey)
C. canaliculatum (Martyn).....
.....C. canaliculatum (Humphrey)
C. costatum (Martyn).....
.....C. ligatum (Gould)

Neptunea lirata (Martyn).....
.....Neptunea lirata (Gmelin)
Purpura foliata (Martyn).....
.....Ceratostoma foliatum (Gmelin)
Tegula pulligo (Martyn).....
.....Tegula pulligo (Gmelin)
Thais lima (Martyn).....
.....Thais lima (Gmelin)

In this connection it might be mentioned that Tucker Abbott made many changes of names in his "American Seashells," some of which are unnecessary. I mention only one: he changed Tegula pulligo (Martyn) to Tegula marcida (Gould), whereas T. pulligo (Gmelin) has priority over Gould's name by about 30 to 40 years.

RS 4/58

FIELD TRIP at SHELL BEACH

The group which collected shells at Shell Beach in Sonoma County decided that it was one of the best ever.

May 24th proved to be a bright but cool day. Twenty-seven species of wild flowers were blooming in profusion along the trail from the top of the cliff to the beach. The tide was low--0.4 at the welcome hour of 9:45 A.M.

The group was small but eager and enthusiastic. It was Hazel Jeschien's first trip and Mary Handley's second, so everything they found was new and exciting.

Virgil Herring and family came and, of course, Virgil in his diving suit helped us a lot. Evelyn Wilson and Mr. Jeschien were supposed to be spectators but as such Mr. Jeschien nearly out collected most of us.

There were over thirty species of starfish, limpets, tegulas, calliostomas, littorines and others of the commoner genera of the outer coast.

(continued)

Among the more interesting were 5 specimens of Ceratostoma foliatum, many of the large key hole limpets, Diodora aspera, a beautiful lavender 20 ray sunflower starfish, Psycnopus helianthoides, and two ocenebras--one O. circumtexta, and the other species not recognized by our group.

Helen Burton

SOME NAME CHANGES among CLAMS

Dr. Ruth D. Turner, in a monographic study of the family Pholadidae, published in "Johnsonia" in 1954 and 1955, shows that the following names should be used:

Nettastomella rostrata (Valenciennes)

instead of Pholadidea rostrata (Val.)

Penitella penita (Conrad)

instead of Pholadidea penita (Conrad)

or Pholadidea sagitta Dall

Barnea subtruncata (Sowerby)

instead of Pholas subtruncata Sowerby

or Barnea pacifica Stearns

Chaceia ovoidea (Gould)

instead of Pholadidea ovoidea (Gould)

The complete list of synonymy in each case includes several other names, which have, however, not been used for some time by most students of this group of clams. We are not giving the whole list for this reason.

RS 9/58

LIBRARY

We have recently received a unique addition to our library from Mrs. May G. Mikelson of San Francisco, a former member.

Mrs. Mikelson has bound most beautifully several sections from different issues of the National Geographic which contain informative shell data and pictures.

Our hearty thanks to "Mrs. Mike," as she is known to her friends, and we hope she'll resume her active membership.

Also our congratulations on her recent exhibit of succulents, cacti and house plants at the San Francisco Flower Show held in the City Hall, where she won several prizes.

H.H.

Definitions:

Conchology, -the study of shells (usually of mollusks and brachiopods).

Malacology, -the study of mollusks, including soft part and shell.

Malacozoology, -the study of living mollusks in their interrelation with their environment, both animate and inanimate; i.e., rocks, plants and other animals.

PERSONALS

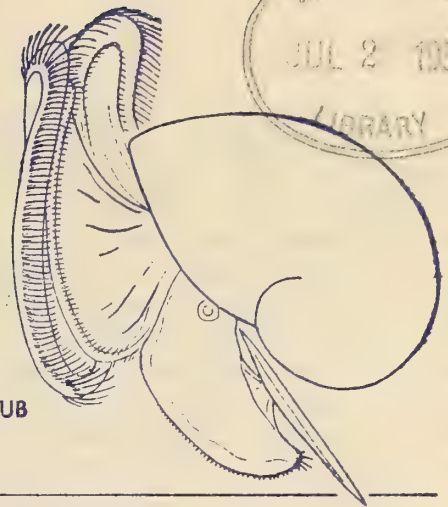
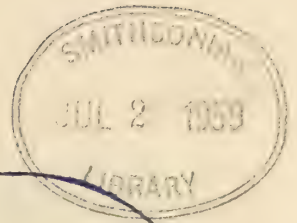
Ned Allison, a 1957-58 UC graduate, was awarded the Dorothy K. Palmer Memorial Prize in Paleontology of \$175 for scholarly achievement. Congratulations!

The delicious punch served at the reception was made by Joseph Rosman from his own recipe.

The door prize at our last meeting, an Antiplanes perversa (Gabb), was won by Joseph Rosman.

There has been a display of beautiful shells from Helen Burton's collection in the main branch of the Oakland Public Library the past month.

Y43
Moll.



THE VELIGER

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NEW YEAR GREETINGS:

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Some observations on the feeding habits of *Conus californicus* Hinds

by
Dr. Paul R. Saunders
Dept. of Pharmacology, School of Medicine
Univ. of Southern California
Los Angeles

The feeding habits of a number of species of Conus have been investigated by other workers, and prey organisms include fishes, other gastropods, and annelids. Direct observations of the capture of some of these animals have been reported in some cases. (e.g., attack upon and subsequent ingestion of certain fishes by Conus striatus). We have recently had the opportunity of observing this phenomenon with several of the tropical species of Conus which have been reported to be capable of producing death in humans. We have observed on many occasions the capture and ingestion of the common tide-pool fish Clinocottus analis australis Hubbs by Conus striatus.

Our specimen of the latter is approximately 80 mm. in length, and it has captured and eaten fish of equivalent length. Similar attacks and feeding upon a variety of southern California gastropods by Conus textile have also been noted. These tropical species were obtained for a study which has been initiated upon the pharmacological actions and chemical nature of the venom of Conus.
Because of uncertainties of supply of the above tropical species, a study has also been initiated by the author and Mrs. Fay Wolfson of San Diego on the feeding habits of Conus californicus as a preliminary step to be followed by a similar study of the
(continued)

venom of this common local species. No case of injury to humans due to attack by C. californicus has been reported, but the species nevertheless possesses essentially the same type of venom apparatus as C. textile and other dangerous species (e.g., "poison duct" and radula teeth). A few preliminary results in these studies on the feeding habits of C. californicus have been obtained and are reported below.

Repeated observations have been made on the capture of Nassarius tegulus (Reeve) and N. perpinguis (Hinds). Introduction of one of these gastropods into a tank containing specimens of Conus californicus may lead almost immediately to evidence of interest on the part of the latter. The white proboscis of the cone is extended (up to almost the length of the cone itself) and is waved back and forth as the cone appears to be attempting to locate the Nassarius. Contact is eventually made between the tip of the proboscis and the foot of the Nassarius, and such contact is followed immediately by ejection of the radula tooth. C. californicus sometimes holds the Nassarius at least briefly, apparently by means of the barbed radula tooth. The Nassarius often manages to free itself from the cone after a few violent movements, and additional attacks by the same cone or other cones may be necessary to subdue the victim completely. A cone then proceeds to feed upon the victim; the Nassarius is removed completely from its shell during this process (usually within 30 minutes). No other gastropod tested to date produces such consistent aggressive behavior by C. californicus as do Nassarius tegulus and N. perpinguis.

Other observations have indicated that Conus californicus attacks and feeds upon other gastropods. The introduction of Nassarius fossatus (Gould) into a tank containing specimens of C. californicus usually leads to extension of the proboscis of some

of the cones, but an actual attack has not yet been observed. However, apparently healthy specimens of N. fossatus have been repeatedly found dead within a few days of being placed in an aquarium with cones, and in each case a number of the latter (up to as many as 20) have been observed feeding upon the Nassarius. Similar observations have been made on a number of occasions on Polinices recluzianus. These studies are being continued with other California gastropods.

ON THE VALUE OF TORSION TO GASTROPODS By

Dr. Ralph I. Smith
Dept. of Zoology, U.C., Berkeley

Unlike other mollusks, gastropods are notable unsymmetrical, and in saying this I do not mean simply that they are coiled. There is in gastropods, quite apart from the coiling, a deep underlying condition called "torsion". Torsion is expressed in the fact that, especially in the more primitive snails, the digestive system opens into a cavity (the mantle cavity or gill chamber) lying behind the head. We note also that in the prosobranch snails the nervous system is twisted into a sort of figure-8 shaped loop. We have to look for the origin of this curious twisted condition back in the embryology of snails, at the period when the veliger larva is developing. At an early stage the larva is perfectly symmetrical, and it remains so until its shell is formed. In front, the larva bears a ciliated velum or set of lobes by which it swims; its mantle cav-

(continued)

ity lies at the rear of the body. Within the body we find at this stage the developing retractor muscles. Originally these were probably a symmetrical pair, designed to pull back the head and velum, but in our gastropod veliger today we see that the retractors do not develop symmetrically on the two sides. Recently the English worker Doris Crofts has shown that the left-hand retractor muscle does not seem to develop, whereas that on the right is quite strong. When the veliger tries to pull in its head, the result is that the body is thrown into a twist. Sounds disastrous, but actually it turns out to be a good thing, for the twisting of the body brings the mantle cavity around to the front, in a position where the velum can be pulled neatly back into it. If the larva had remained symmetrical, this would have been impossible, for the foot lay between the velum in front and the mantle cavity behind.

If we watch the process of torsion, we find that in the more primitive snails the muscles start the twisting process, and in a few hours swing the body into a left-handed (counterclockwise) twist. After this, the next few days of growth complete the process, and torsion is fulfilled. It is thought that this process is the result of a larval mutation or sudden change in the developmental process, which proved to be so useful to the ancestral veliger larvae that the trait has survived. It is characteristic of all the gastropods today, these being descended from the ancient stock in which the trait first appeared, probably back in the Cambrian period, almost 500,000,000 years ago, to judge by fossil remains.

It is true that many modern gastropods undergo a considerable amount of "detorsion" during development, and some, such as the nudibranchs and tectibranchs, have

to a considerable degree straightened out again, yet their larvae show marked torsion at an early stage. Among the results of the torsion in gastropods are probably such effects as the loss of one kidney and one of the auricles of the heart, the loss of one gill, and possibly the characteristic coiling of the shell.

We have said that torsion is probably of survival value to the veliger larva; is it of any value to the adult? John Morton, another leading English student of mollusks, thinks so. In a recent paper he points out that the position of the mantle cavity in front means that the snail can take in water for respiration from ahead, rather than from its wake where silt and debris are stirred up by its foot in creeping. Also, by means of its siphon, a snail can sample (taste or smell) the water in front of it as it goes about, thus having in the siphon what amounts to a movable nostril, a useful device when an animal is seeking a meal or on the lookout for danger.

The idea that torsion was originally of survival value to the veliger larva was first put forth by the late Walter Garstang, another leading English biologist. Garstang wrote a number of detailed scientific papers, but was also in the habit of expressing his ideas in verse. About torsion, he composed "The Ballad of the Veliger, or How the Gastropod Got its Twist"; I cannot resist quoting a few lines:

"The veliger's a lively tar, the
liveliest afloat,
A whirring wheel on either side
propels his little boat";

Garstang goes on to tell how he thought the pre-gastropod veligers

(continued)

suffered by being unable to pull entirely back into their shells, and so fell prey to various enemies, but then:

"A fleet of fry turned out one day,
eventful in the sequel,

Whose right and left retractors on
the two sides were unequal:

Their starboard halliards fixed
astern alone supplied the head,

While those sport were spread abeam
and served the back instead.

Predaceous foes, still drifting by
in numbers unabated,

Were baffled now by tactics which
their dining plans frustrated.

Their prey upon alarm collapsed,
but promptly turned about,

With the tender morsel safe within
and the horny foot without!"

.....
The "Slug-with-the-shell-on-its-tail".

NOMC members will recall Dr. Cadet Hand's exhibit of live specimens of the slug-with-the-shell-on-its-tail (Testacella haliotoidea Draparnaud) at the AMUPD meeting in Berkeley this summer. His slugs came from the Berkeley campus of the University. A few days ago Miss Georgia Holtz, 343 Nevada Street, San Francisco, brought to the Academy of Sciences three of these slugs that she had collected in her garden. This is the first certain San Francisco record for this interesting slug, which is a burrower and feeds on earthworms. It is another one of our European introductions that seems to be getting a foot-hold in local gardens.

Allyn G. Smith 11/20/58

A Fossil Hunt Near Home

A shell collector sometimes wonders what shells looked like in ancient times. The way one finds out these things is through fossils.

Most people think fossils are rare and hard to find but there are many places in California where numerous fossils may be found. Such a place is near the small town of Selby in Contra Costa County on Highway 40, where many have been introduced to the adventures of shell collecting.

It took us half of the day, my friend and I, to ride our bikes from Berkeley to Rodeo, where we were to stay at a friend's house during our hunt. We were excited, but we rested some and planned our attack on the fossils the next day. Up early the following morning, we headed for Selby and the fossils. We did this for three days and I found many more fossils than I got on the fossil hunt at the end of the convention.

I found many large sand dollars, some very fine pectens, two different types of snails, some oval fossils of which I have three, and which I think are sea urchins, many clams, and a giant razor clam.

Like all good things our trip had to end, but we did have three wonderful days of fossil hunting.

Neil Marshall
(our youngest member
age 12 years)

WHY RULES OF PRIORITY

In the second number of the Veliger there were given two lists of names replacing some that have been used, in a few instances, for a great number of years. The novice- and sometimes even the somewhat more advanced student - in any field of biological endeavor, finds these name changes rather confusing until he understands the reasons for them.

Our present system of nomenclature is based on the work of the famous Swedish scientist, Linnaeus or Linne, who in 1758 introduced the now generally adopted method of naming organisms. Up to his time, and even for some years after the publication of the classical Systema Naturae, scientists applied whole strings of descriptive terms as the name of the species they considered as newly discovered. Since the tenth edition of the Systema Naturae, however, any species is designated only by two words, the first being the genus name and the second being the species name.

The adoption of the so-called binomial system brought about a great simplification in the science of taxonomy. However, much confusion was still introduced by various authors for one reason or another. The first and, perhaps, principal reason was the fact that often a worker would receive, for example, a shell of a mollusk without accurate locality data. It appeared to him as a "new species" and, consequently, he went ahead and described it and named it, unaware, perhaps, that that species had already been described by some previous author. He could not be blamed for not knowing this, since, in those days the exchange of information, even in printed form, was much slower than it is to-day. The same situation may obtain even in our modern day

and age, as it may be sometimes many months from the time a manuscript has been accepted for publication and the time when the printed paper appears. In the interval somebody else with access to more rapid means of publication may also have described the same "new" species and we may then have the situation where, within a few days of each other, one "new" species is described by two different authors and given two different names.

The early authors had some quaint ideas - at least they appear so to us to-day- about naming living creatures. If, for example, a writer found that his "new" animal was green he might apply the adjective viridis to the genus name. But some later worker, having perhaps a fairly good series of the same species would observe that green was the exceptional color and that the majority of individuals were actually sky-blue; he would then change the name of the species from viridis to caeruleus. Still later, students might further add to the confusion by renaming the same species in honor of somebody whom they wished to make favorably inclined to their endeavors.

And still another situation may have arisen. We are all quite familiar with the human species and we easily recognize that there is a tremendous individual variation. While there seems little difficulty for most people to recognize that all persons, though quite different, one from another, belong to one and the same species - i.e. the human species - it is not always equally easy to recognize what constitutes individual variation and what is a specific character difference. Thus, many early authors may have described what we now know to be merely individual variants of one and the same species as so many different species; and, what

(continued)

may make it even more surprising to us, they may have described their "different" species in the same paper, one after the other. Also, we know to-day that many species show very marked sexual dimorphism, which merely means that males and females of the same species are very markedly different from each other; so different, in fact, that even to-day they might be thought of as belonging to two different species, unless anatomical studies are made.

To mention one last situation that can occur - and actually has - is that the same author, after the intervening of a number of years, re-describes a species or variety and gives it a new name, without remembering having already named that very same specimen many years ago. This is not apt to happen very often, and can be understood only in the case of unusually productive taxonomists who also happen to live an unusually long active life.

But not all name changes necessary to-day are as easily understandable as they are in the cases just discussed. Sometimes the advance of science shows that what had heretofore been considered as closely related to some particular species is, in actuality not at all or, only very distantly related; it then may be necessary to transfer the particular "species" into another genus or, in some cases, even into another family.

In our next article we will take up the discussion of some of the rules which have been adopted on an international basis to bring order into what otherwise would be a tremendous chaos.

R. Stohler 10-58

MARINE ALGAE or SEaweEDS (continued)

In the last issue we covered the general description, habitats, structure, and reproduction of plants in the ocean. Now let us turn to their practical and commercial uses.

There are three major groups of algae, based upon the color pigment most important in the life processes of the plant -- not necessarily the one most obvious to our sight. They are: the greens, growing between tide levels; the reds, most of which grow at levels below lowest tide, but which are often cast ashore; and the browns, which grow at all levels, often reaching up 100 feet to the surface.

It is these larger, more noticeable brown ones which both scientist and layman call kelp. Originally this term was used only for the ashes of burned sea weeds, much used as fertilizer in Europe.

These plants are also sought for their chemical content. Kelp was long a principal source of iodine and potash. In 1929 a factory was established in Monterey for the chopping, drying and shipment of our largest local kelp. It was harvested from the ocean off shore of central California and the dried product was used by eastern firms in the manufacture of rayon. About 450 tons were harvested in 1931; this factory no longer operates.

Also obtainable from some kelp is a product known as alginic acid which is used in making ice cream to impart that smooth creaminess, and in pies as a filler. It is also used to add body to whipped cream.

Another commercially valuable product is derived from certain red algae. It is agar agar, important in bacteriology as a culture medium, as well as in jellies and candy.

(continued)

For many years Japan was our principal source for this product, some of which they had harvested in our waters. The recent war caused an increase in our domestic processing of that commodity. The State Fish and Game Commission has control of the kelp beds and stringent laws are in effect to govern its cutting.

As a food for direct human consumption, sea weeds have long been used in Europe, and Orientals can prepare them in enough varieties to form a complete meal. For many years there has been a thriving industry along our coast in which certain algae are harvested and dried for shipment to the Orient. A very common local green form, Ulva, is called sea lettuce because of its world wide use in the salad bowl; try it!

You may bring these very interesting plants into your life. Here are instructions for the very simple, inexpensive mounting of sea weeds:

1. Float the plant in a shallow pan of sea water. (Fresh water may cause an osmotic bursting of the cells and loss of color.)
2. Slip drawing paper into the water under the plants and lift them up and out. Arrange as you wish.
3. Lay cheese cloth over the plant.
4. Place all this in a folder of old newspaper and put between heavy blotting paper.
5. When you have built up a "Dagwood" stack in the above manner, place a board on top and on this put bricks or rocks for weight.

6. Change blotting paper, only, daily for three days. Dry the damp blotters in the sun.
7. After the three days, remove algae sheets and carefully skin off the cheese cloth.
8. Let the sheets dry slowly in a warm room.

They are now ready to frame behind glass or bind into a book. Most of our local algae will adhere, for there is enough mucilage in the plant. Heavy pieces which won't stick can be "strapped" on with scotch tape. Many of the finer red varieties have been used on Christmas cards, valentines, stationery, cards etc.

Merton E. Hinshaw

Gardeners, ALERT!

Among slug and snail pests in the garden of Miss Georgia Holtz, 343 Nevada Street, San Francisco, is what is evidently a thriving colony of the Milky Snail (Otala lactea Muller). This is a large handsome snail, white, or whitish with revolving black bands. It comes originally from the Mediterranean area. This new garden pest is as bad or worse than the European Brown Snail (Helix aspersa Muller), once it gets a start. It was discovered shortly after WW II in the old Farmer's Market area at the end of the Bayshore Highway and Alemany Boulevard where it covered about a block area. Efforts to eradicate it were made by the Pest Control Division of the State Department of Agriculture, evidently without success as it is still in the area. Don't let this one get a start in the East Bay! If found, report it immediately to Allyn Smith or Dr. Hanna at the California Academy.

Allyn G. Smith

New River Snail from the Eagle Lake Region

In June, 1877, Mr. Henry W. Henshaw, an eminent ornithologist and naturalist, collected a large series of highly-sculptured river-snails at "Eagle Lake" in Lassen County, California. Robert E. C. Stearns described and figured these as new in 1890, calling them "Melania (?) Goniobasis acutifilosa" because of their many sharp spiral carinae on all the whorls. Keep's West Coast Shells has a picture of a young specimen (p.197, fig. 177). Subsequent attempts to find this snail in Eagle Lake have failed, and until recently it has been "lost".

While on an Academy of Sciences collecting trip into northeastern California in September, 1958, Eagle Lake was visited again in a search for this species. After several unsuccessful tries at likely spots Goniobasis acutifilosa (Stearns) was finally found, not in the lake as originally inferred but in a large spring several miles distant. Here it occurs in great profusion, although in a rather limited area. A large series of specimens was collected from babies recently hatched to full grown shells an inch and a half long. Thus, another one of California's "lost" species can be crossed off the list.

Allyn G. Smith 11/20/58

Do You Know These?

The February issue of Sunset Magazine will carry an article on California and Hawaiian snail pests, illustrated in color from specimens selected from the research collection at the California Academy of Sciences. Gardeners as well as conchologists will be interested. Look for it.

AGS

Trawlers Find New Marine Snail

Mr. Everett C. Stiles of Bellingham, Washington, has been obtaining specimens of a large new carnivorous marine snail from trawl fishermen working in 100 fathoms off the coast of Washington. This belongs to the genus Beringius in the family Neptunidae. Similar shells have been taken as far north as Chignik, Alaska. Almost all known specimens of this big, heavily-ribbed gastropod have been available to me for study. It is expected that it will be described and adequately figured before long, possibly in "The Nautilus".

Allyn G. Smith

DERIVATION OF NEW SPECIES OF MOLLUSCA

by

Dr. Jens M. Ostergaard

Problems in taxonomy of the mollusca consist of determining the degree of relationship between individuals and between groups. This is not easy, for many factors entering in are not well known. Usually the shell is our only source for determining relationship, while the anatomy of the mollusk might be of greater value.

The investigations of Allison Kay of the University of Hawaii give promise of a solution to some of our taxonomic problems; she has made dissections of the female reproductive system and studied the radula of many Hawaiian species of Cypraea.

It is not the relationship of the major groups I shall deal with here,
(continued)

rather the differences of less than specific importance, which are as follows: 1) Individual variations, 2) Sexual differences, 3) Ecological variations, 4) Pathological differences, 5) Racial differences.

Individual Variations

In order to get an appreciation of individual variation, one should study a fairly large population. But how are we to know that the population is not mixed? One might ask. If the group of mollusks is concentrated in a small area and its individuals are of the same age as their stage of development would indicate - we can reasonably conclude they are members of the same brood.

As an example, I found during the month of July, 1926, a colony of Strombus gibberulus Linnaeus at low tide close to shore on the north shore of the island of Tongatabu, Tonga, which consisted of about 50 adult individuals concentrated in an area with a radius of only about 20 feet. But for miles along the shore not another individual of the species was to be found, although conditions seemed to be identical in many places. The mollusks in this colony exhibited a wide range of coloration, from white to dark brown.

Sexual Differences

In the dioecious species of mollusks, in which the sexes are separate, there might not be any obvious difference visible in shell characters, but be restricted to anatomical parts only.

Ecological Variations

Ecological variations play a very important part in differentiation within the species of many mollusks, and they might often be misinterpreted as racial characters.

As an example, while collecting on the north, or leeward, shore of the

island of Tongatabu, Tonga, I observed differences, in size mainly, in two species of Cypraea - errones and vitellus - which occurred in large numbers about four miles apart under different reef conditions.

Likewise, on Oahu, Hawaiian Islands, where Cypraea caputserpentis is so common, differences are readily observed in shell characters between those that live on open beaches exposed to the surf, and those that live in sheltered bays.

Pathological Differences

In the so called pathological variations we come to the most striking example of differences occurring within a species. Many such pathological forms have received specific names by conchologists, to which, of course, they are not entitled. It is assumed that a diseased condition is responsible. In many species of Cypraea the change effected involves the shell to such an extent that color, as well as form is changed. Some assume a rostrate form; in others the color, only is affected; but commonly the form as well as coloring is changed. Its occurrence is largely restricted to certain geographical areas. A region including New Caledonia and extending to the coast of Queensland, Australia, shows the greatest number of species so affected.

Racial Differences

Coming to the last in our category of groups - racial differences - we are closest to the species, for the bridge here may easily be crossed; and many are the uncertainties in the mind of the taxonomist as to their true rank - racial or specific.

When such differences in some characters of a species of mollusks are restricted to a certain geographical area, we speak of them as "Geographical races" or "Subspecies", as some prefer to call them. They differ from ecological variations in that their

(continued)

characters are of a hereditary nature, like those of the species. Yet, they differ in a lesser degree from the species to which they belong than two species do from each other.

These geographical races or subspecies are either known or assumed to connect up with the species by an intermediate link. Now, should such an intermediate link be eliminated, the result would be a new species! We may then consider them as potential species and assume that a great many new species are on their way. That is not so; for most of them come to naught in various ways.

The Species

A species of mollusk may be defined as follows: a group of similar individuals which differ in one or more basic characters from the individuals of any other group, and which rarely cross individuals of any other group, though they might be closely related.

The essential factors in species formation among the mollusks seem to be environment and isolation. Another factor may be mutation, by which a new species may suddenly come into being.

Environment and Isolation

In the Red Sea we can count 5 species of Cypraea whose closest allies occur in the Indian and in the Pacific Ocean. These are with their progenitors: C. camelopardalis Perry from C. vitellus Linnaeus, C. pantherina Solander from C. tigris Linnaeus, C. pulchra Gray from C. isabella Linnaeus, C. exusta Sowerby from C. talpa Linnaeus, C. nebritis Melvill from C. erosa Linnaeus.

The Red Sea is a long and comparatively narrow body of water, with the hot Arabian desert on one side and the Sahara on the other; its waters reach a high temperature that would

serve as a climatic barrier and thus produce a condition of isolation.

Similarly, South Africa with its temperate climate has its own molluscan fauna in which we find species of Cypraea of peculiar forms.

In the Atlantic, Northwest Africa with its geographical isolation has its own types.

Hawaii, with its vast expanse of ocean serving as a barrier, presents us with many species and subspecies of marine mollusks. Here, too, the land snails of the family Achatinellidae, have probably contributed more to an understanding of the role of isolation as a factor in the evolution of new species.

The late John Thomas Gulick made the observation that species of Achatinella occurring in adjoining valleys on the island of Oahu, and found at the same altitude and apparently under similar conditions, indicated a less close relationship to each other than they showed to those of the same valley that lived at a higher altitude and under different conditions.

In considering the causes leading to the formation of new species of mollusks derived from older ones, the endemic or partly endemic species of the Red Sea may be taken as an example.

From its starting point (center of origin) a species spreads out in an ever increasing radius till it encounters barriers, which may be climatic, geographical or environmental. At the periphery of its distribution an adaptation to adverse conditions becomes a requirement for its survival with the results that "Natural Selection" acts as a factor in preserving new characters resultant from its adaptation, while members of its own original stock are prevented from intercrossing with the so adapted new form and neutralizing the new characters acquired. Thus isolation contributes to species formation.

(continued)

It appears there are many requirements for the successful establishment of a new species and that many species are unsuccessful and survive for short periods only. On the other hand, some show great racial longevity. The Dutch geologist, Dr. C. Beets, reports finding Cypraea vitellus in the Upper Miocene of East Borneo, eleven ^{million} years old, while others report it considerably earlier from Java.

Mutation

The factors of mutation in species formation appear to be rather elusive, for the changes are radical and abrupt. They are problems of genetics. An accident to the chromosomes may cause a rearrangement of the hereditary genes.

In 1918 I located the fossil shell of a small species of Strombus in a limestone quarry at Wailupe, near Honolulu, which I could not identify. The limestone is late Pleistocene and appears at many places along the shores of the island of Oahu. Later I found several more specimens in various places of the same limestone; among these there were some that showed strong intermediate characters between the first mentioned fossil shell and the common Strombus maculatus Sowerby. This fact convinced me that my fossil Strombus had been derived from S. maculatus. The fossils had no colors, but others dredged from Honolulu Harbor showed traces of a color pattern and indicated to have lived at a more recent time, although none were found living. I sent specimens of this Strombus to the late Dr. Henry Pilsbry, who honored me by naming it for me.

Recently I received a fresh specimen of it from Okinawa, which led me to believe that in its larval stage it had been carried from Hawaii by the Japan Current.

When in the Palau Islands, the late Dan Langford found an unusual specimen of Cypraea in its living state, which he sent to Mr. Thaanum of Honolulu, who

showed it to me. It was the size and form of C. helvola, but white on the ventral side and black on the dorsal.

Sometime later Mr. Thaanum showed it to me again. It had faded a little, so that the C. helvola markings on the dorsal side became visible.

SCUBA DIVERS add NEW SPECIES

A paper by Dr. Rudolf Stohler describing a fine new Top Shell of the genus Astraea is in proof form and will appear soon in the Proceedings of the California Academy of Sciences, fourth series. Also described is a new large species in the Family Liostidae, genus Macrarenia. Both have been brought in by SCUBA divers from off southern California.

A.G.S.

CLUB NOTES

Warm greetings were extended at our October 7 meeting to the many visitors present; our special guests being those from the Sacramento Valley Conchological Society who had enjoyed the AMUPD convention here in June. Roseville, Healdsburg, Albany, Lafayette, Colfax, Concord, Rancho Cordova, Travis Air Force Base, Oakland and Berkeley were also represented, with several joining the club.

After a brief business session Dr. Stohler talked on "The Scientific Value of SCUBA Diving", and also showed some pictures of a new species of Astraea.

As Gladys Archerd, Hospitality Chairman, was unable to be present Kris Rosman assumed the post and, with her committee, was most efficient in making our visitors feel welcome.

Marianna Paulson and Lucille Zellers were hostesses, serving coffee and apple juice, also delicious cookies and confections which filled Tridacna shells. The attractive center piece was by Hazel Jeschien.

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Formerly a short business session, followed by the presentation of the nominating committee of the next year's officers, was held at the Christmas party. This procedure is now changed.

At the November 4 meeting the new officers for the year 1959 were elected and they, together with the other members, extend a Happy New Year to all.

Personals

Thirty-five eager shell collectors responded to Helen Burton's invitation to a party at her home on October 24. Her main object was the disposal of some unsolicited shells from Australia. This was accomplished, as she reported at the November 4 meeting. Buying, selling, exchanging, and identifying shells kept every one busy, after which delicious refreshments were served. Altogether, it was a "big" party as she had promised.

Hazel Jeschien is arousing the interest of folks outside our Shell Club in the beauty of mollusks. Her talk for the Northbrae Woman's Club at the 20th Century Club House on October 21 was enthusiastically received. Of additional interest was the beautiful collection of pictures she presented, "Seaside Oddities", loaned by the Standard Oil Company.

Previously she had been the guest speaker at the home of Mrs. Wiegand of Berkeley, who was hostess to the P. E. O. group.

Gladys Archerd went fishing. Two good strikes and nothing to show but a baitless hook. She thought it must be a "big" one, so once more she cast, victorious this time. It was a "big" one - a clam! Some mollusks apparently make the supreme effort to be captured by a shell collector.

Christmas Party

Ruth and Philip Bancroft were again most gracious hosts at their home in Walnut Creek for the Club's Christmas party.

Little Miss Kathy Bancroft introduced a special note of happiness by singing "Over the Mountain"; after which we enjoyed a delicious dessert. Kathy then drew the lucky numbers of those receiving shells.

Mr. Carey Balwin, Director of the San Francisco Zoo, was the guest speaker and the recital of his and others' experiences with animals of the Zoo was most humorous.

At the close of his talk Helen Burton read some appropriate verses of her composing, all the while holding a small piggy bank. She knew the "pigs aren't kept at the Zoo", but hoped that "this one will find a home there", shaking it as she spoke. A sound of clinking metal followed, so we felt that the piggy had been well fed, as she handed it to Mr. Balwin.

Some intimate friends of John Saxby, our retiring president, presented him with a beautiful Camellia shrub, redwood tub and trellis, to add another spot of beauty to his new home in San Francisco.

Many of us were still chuckling as we left for home. It was a delightful party.

Dead lines for April no., Feb. 15th; for July no., May 15th; for Oct. no., Aug. 15th; for Jan. no., Nov. 15th.

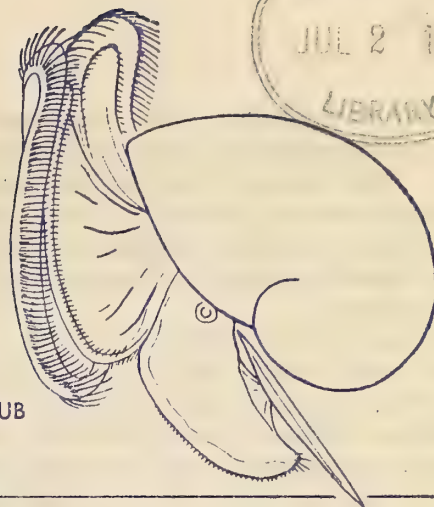
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BEACH COLLECTING IN THE ARCTIC

by

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One of the first questions asked by a marine biologist who contemplates a summer trip to the Arctic or Sub-Arctic is: How is the beach collecting? Broadly speaking, the answer is: No good!

The area involved in this discussion is confined to the northern part of the Bering Sea and the shores of the Arctic Ocean as far eastward as Demarcation Point. The barrenness of the beaches of remains of organisms and paucity of living animals in rocky littoral areas is one of the most striking features of these shore lines. Only rarely can the beach comber pick up a battered shell or sea urchin. In the littoral zone he can wear himself out turning rocks and searching crevices and he is lucky if he gathers a handful if he takes everything he sees.

This seems paradoxical because it is well known that these cold northern waters are teeming with marine life. Nearly all of the major invertebrate groups are represented by unbelievable

numbers of individuals. It has been said and is believed to be true that there are more individual animals per square meter of bottom or cubic meter of water in the Arctic than in comparable areas or quantities in the temperate or tropical zones. Therefore, there must be a profound reason for the barren beaches.

The reason appears to be the formation of ice anchored to shores and bottom in winter in these northern waters. The thickness of the ice formed at Point Barrow, Alaska, each winter is five to six feet. Naturally, there is no free water under it out to that depth and tidal rise and fall is often measured in inches rather than feet. In the spring break up the floes become a jumbled mass of giant cakes, many upended by currents or winds. Many of these reach bottom down to depths of 75 to 100 feet and do an effective job of plowing up the bottom. This disturbance is not conducive to healthy growth of marine bottom life.

On rare occasions a summer storm will sweep in on shore a multitude of living things from out beyond the effect of the ice. Once Dr. W. H. Dall found the beach at the northeast corner of Nunivak Island literally
(continued)

covered with shells, the only good shore collecting he ever found in the north. Dr. George MacGinitie found a similar condition once at Point Barrow and being a general zoologist he collected great numbers of species of many groups.

(Smithson. Misc. Coll. Vol. 128 No. 9, Publ. 4221, pp. 1-1V, 1-201, pls. 1-8, November 30, 1955.)

On Deadman Island east of Point Barrow I found many shells in 1954 and likewise at Wainwright. The situation was not repeated in the three following summers.

In dredging out beyond the 100 foot line, however, marine life was unbelievably abundant. Every square inch of bottom seemed to be occupied.

Free swimming things such as Crustacea, pteropods and small fishes can be taken in large numbers with nets or traps in summer or through holes in the ice in winter. An enterprising zoologist can find much of interest in Arctic waters any day of the year if he accepts a few basic facts regarding the environment.

THE TROCHUS NILOTICUS FISHERY OF MICRONESIA

by

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Few tropical marine gastropods have been studied as intensively as Trochus niloticus. The reason for this interest is that T. niloticus has for many years been an important export item for many of the islands of the Indo-Australian archipelago, Melanesia and Micronesia. The shell is used primarily for mother-of-pearl buttons, jewelry and inlay work. Although it is not as desirable as the pearl oyster (Pinctada maxima and P. margaritifera) for these purposes, the diminishing supply of the latter

has helped to increase the demand for Trochus shell in recent years. Little fabrication of the final product is done in the islands, however, and most of the shell is shipped to Japanese and European button factories. The soft parts of the animal are generally used as food by the divers. In parts of Micronesia, at least, the shell had some limited uses for ornamental purposes even before the arrival of western man. Beautiful mother-of-pearl bracelets are still worn by the women of Yap and Palau, especially during dances because of the rhythmical klinking noise produced by a dozen or so on each arm. It is interesting to note that the Palauan word for bracelet is the onomatopoeic "klilt".

The objective in all of these Trochus studies was to learn enough about the animal so that they might be properly conserved and thus provide a badly needed constant source of income for the native peoples of these islands. Unfortunately this objective has not been met. There has been a constant decline in the size of the catch from almost all of the Trochus producing areas of the Pacific. This has happened in spite of regulations which limited the length of the fishing season and established minimum legal sizes. New Caledonia and the Philippines, each of which produced over 1000 tons per year during the pre-World War II period, now are producing less than 300 tons per year each. A similar decline in the size of the catch took place in the Andaman Islands in the 1930's and in Palau and Yap in the 1940's. Catch data and certain other records from these islands indicate that, without doubt, over-fishing was the cause for these population declines, thus implying that the existing conservation practices were ineffective.

In order to prevent a total collapse of the fishery the French Institute d'Océanie at New Caledonia in 1953 began a three year program of research on Trochus. Two years later a similar program was begun in

the U. S. Trust Territory of the Pacific Islands (the former Japanese Mandate of Micronesia). The Micronesian study was of particular interest because of the fact that between the years 1930 and 1940 the Japanese carried out rather extensive transplantations of *Trochus* from islands where it was indigenous (Yap and Palau) to the Eastern Carolines, Marshalls and Marianas. Because of the war the Japanese biologists did not have an opportunity to assess the results of these introductions and no one really knew how extensively *Trochus* was distributed or how successful the introductions were. One of the main objectives of the American program in the Trust Territory was to survey these islands where *Trochus* was reported to have been introduced in order to answer these questions, and to estimate the abundance and rate of spread of the animal.

Using aqua-lungs, the author and two Palauan assistants made transect surveys to depths of about 80 feet at selected points on the lagoon and seaward sides of barrier reefs of 18 islands and atolls throughout Micronesia. The results of these surveys showed that where *Trochus* had been introduced to high island barrier reefs they were very successful in populating the entire seaward edge of the barrier reefs and that these populations were of "commercial" abundance. On the other hand, where *Trochus* had been introduced to atoll reefs they had either not survived or were present in limited numbers. Furthermore, these "atoll" populations were found primarily on the lagoon side of the reef.

The natural, endemic populations of *Trochus* at Palau and Yap are almost never found inside the lagoon but rather live on the outer (seaward) edge of the barrier reefs where there is plenty of strong wave action. The reasons are not fully understood but several possibilities exist. It is known that *Trochus* requires a good supply of oxygen for

its metabolic processes and that natural populations tend to live only in areas where the waters are well aerated. The lagoons of most high islands are poorly ventilated and the O_2 tension of the water is lower than that of the open ocean. Atoll lagoons, however, are very well ventilated and the oxygen content of their waters is as high as that of the ocean outside. In addition the physical and biological structure of these two types of barrier reefs differ. The lagoon side of atoll reefs resembles the seaward side of high island reefs, with abundant stony coral rock formations. The seaward sides of atoll reefs, however, are made up primarily of calcareous algae with relatively few of the true stony corals present. This difference in biological structure makes for a great difference in the physical appearance of the reef, and it is obvious that there are far fewer habitats for *Trochus* on atoll reefs. This is especially evident when one examines the outer slope of the reef that is below the tidal range. In the case of atolls this is relatively steep but on high islands the slope is gentle and forms a rather wide shelf where many *trochus* may be found.

In addition to this survey work in Micronesia other studies were done on the reproduction, feeding, zonation and size frequency distribution of populations. Mainly as a result of these studies a new conservation scheme was recommended and is being put into effect. This plan is based on the sanctuary theory and it consists of setting aside small reef sectors as a sort of a nursery ground for larval *Trochus*. It is hoped that these areas will provide enough of the planktonic larvae to "seed" the rest of the reef, adding to the total number of juveniles present and increasing the probability that a greater total number will survive to adult stages.

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There is still a great amount of work to be done, however, if we are to fully understand this population problem. The French study in New Caledonia, which was concerned primarily with growth rate determinations, suffered a severe set back when M. René Gail, the biologist in charge of the project, failed to return to the surface from a dive he was making in connection with his work. His project is being continued by another man. There is at present no Trochus research being carried on in the Trust Territory, but rather elaborate catch statistics are being collected and it is possible that with this and other data, an estimate may be made of the total size of the Trochus population existing on the reefs. With the proper data similar estimates will be possible for past years back to and including the year when the population began to decline. This information may then be used for further estimates of the intensity of the fishing effort, survival rate and perhaps total carrying capacity of the reef. Such estimates will serve as valuable guides for future studies and conservation schemes.

SOME OBSERVATIONS ON THE GEOLOGY OF CERTAIN ISLANDS OF MICRONESIA

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University of California, Berkeley

.....
This paper was read at our January
meeting when lantern slides augmented
and illustrated the data.
.....

..(Ed.)

Oceanic islands owe their origin, at least initially, to volcanic activity. They have their foundations in the floor of the deep ocean and represent the peaks (or position of peaks) of vast submarine mountain ranges. These islands can be classified as two major types; low islands and high islands.

Low islands have elevations rarely in excess of seven feet above sea level. They are composed of limestone derived from coral and algal skeletons and other organic remains. High islands on the other hand can be defined as having greater elevations than low islands, usually well in excess of seven feet. Islands of this type are generally composed of volcanic material.

Knowledge of the general conditions under which coraliferous limestone is laid down is important for an understanding of coral reef formations. Reef building corals are restricted to tropical areas where the surface water temperatures are 20°C or warmer. Reef building corals produce massive solid structures, made up of the skeletons of generations of polyps. Such corals have very specific growth requirements besides temperature. They require clear, well oxygenated ocean water. Their lower limit of vigorous growth is but rarely as much as fifty meters below sea level. They can stand little or no exposure to the air and therefore their upper limit of growth is determined by the lowest low tides.

Geologists recognized early that high oceanic islands are predominantly volcanic. The low islands of deep warm tropical seas are often circular coral reefs (atolls) surrounding relatively shallow lagoons. As the corals could not possibly have grown up from the floor of the deep ocean, was it not logical then to conclude that such islands were produced by corals growing around the rims of extinct volcanoes that rose somewhat short of the surface? Darwin (1839) mused over the great improbability of submarine mountain ranges having their cratered peaks at so uniform a depth as to allow corals to produce such atolls.

Lyell had suggested to Darwin the
(continued)

possibility of subsidence as a factor in the formation of atolls. If land can rise in one area, as evidenced by marine remains found at relatively high elevations, it most certainly can go down in another, he reasoned. Darwin observed that islands showing signs of subsidence occurred generally in groups or bands in the ocean as did those showing emergence. Between the two types lay an intermediate zone with some islands apparently going up, others going down, while still others seemed to remain relatively static. Darwin studied charts and showed these bands alternated with each other from the eastern Pacific to the western Indian Ocean. He felt that atolls mark the position of volcanic peaks that at one time stood above sea level. These peaks must have extended above the surface of the sea to varying elevations. Those in areas favorable for reef building corals first supported fringing reefs. As the mountain range slowly submerged the corals grew vertically upwards keeping pace with the relative rise in the surface of the ocean. Between the outer edge of the growing reef and the shrinking high island, conditions were unfavorable for rapid coral growth due to turbidity, relatively low oxygen and perhaps fresh water drainage impoundment. Hence the reef became separated from the island by an inner, relatively shallow lagoon. With continued subsidence the volcanic island sank below sea level, while its encircling reef continued to keep pace with the surface. Corals carried deeper, out of the region of favorable growth conditions, died, and their skeletons became the foundation for vigorous corals in their struggle to keep near the surface. The reef limestone of calcareous skeletons became cemented in place by growing corals, certain algae and physical-chemical agents. Thus the reef foundation is generally compact solid material and visible in it are remains of ancient coral colonies, entombed in a matrix of the remains of their kind.

There is little question to-day that subsidence has played an important role in the production of many coral reefs. Drillings and seismic soundings of certain atolls have shown that the foundation limestone may extend down below the surface of the ocean as much as 800 meters; nearly twenty times deeper than reef building corals can grow.

Darwin supposed that reef islets were produced from the accumulation of material thrown up from the reef itself. The nearly uniform elevation of such islets he attributed to the height to which wind and waves could pile fragmented reef material. It is curious how so brilliant an observer could have failed to grasp that destruction, not growth, was taking place on the reef flats and reef islets. He says in his Journal of Researches, "There is simplicity in the barrier-like beach,, the solid reef flat of the coral rock, strewn here and there with great fragments, ... It is not that the ocean spares the rock of coral; (for) ... great fragments (are) scattered over the reef, and accumulated on the beach,". Here were the clues, but perhaps he was too awed by the resistance of the living reef front to wave action, to recognize them, for he goes on to say, "It is impossible to behold these waves without feeling a conviction that an island, though built of hardest rock,, would ultimately yield and be demolished by such irresistible forces. Yet these low, insignificant coral islets stand: for here another power (reef building coral) takes part in the contest". It is true that the reef front supports living coral, but the reef flat behind it is anything but growing. Layers of its surface are often delaminating; vigorous coral growth is rare, and signs of chemical erosion are numerous. A rampart of

(continued)

rock along the beach terrace may buffer the islets from wave action, but often this rock rampart is swept away exposing old basement limestone that was formed beneath the surface of the sea and not by the cementation of particles thrown above high tide by wind and waves.

If reef islets were not produced by the accumulation of materials from a slowly subsiding actively growing reef, as Darwin proposed, to what do they owe their origin? The answer cannot be given until we discuss the Glacial Control Theory proposed by Daly (1910).

Corals of the warm seas flourished prior to Pleistocene glaciation. Undoubtedly there were extensive coral reefs. Atolls developed in subsidence areas as productions of the processes described by Darwin. However, these atolls probably differed conspicuously from atolls of to-day. They were more likely circular reefs standing alone in the ocean marked only by the breaking of the surf, and a change of water color due to shallowness.

During Pleistocene glaciation of the continents the sea level dropped at a relatively rapid rate, producing what can be termed "relative emergence" of all land masses. Continents were terraced and many small oceanic islands, volcanic as well as limestone reefs and atolls, were planed off to the level of the falling sea. Cooling of oceans probably killed corals in many areas facilitating the planing process. Sea level dropped as much as 50 meters according to Daly.

With the milder climates that followed and the subsequent melting and withdrawal of the glaciers the oceans began to rise and their waters to warm. In response, coral began to grow upwards, where conditions were favorable, on perimeters of the truncate platforms that had been created by the planing action of the Pleistocene sea. The phenomenon was world wide and helps explain the nearly uniform depth of lagoons where ever atolls occur. However, like Darwin's theory, it fails to explain the

nearly uniform height of atoll islets we see to-day.

Kuenen (1950) has combined the theories of Darwin and Daly, and proposes a Glacial Control-Subsidence Theory. In short the theory takes into account general subsidence as an explanation for the great depth to which coral foundations of atolls extend, and Pleistocene glaciation for the uniform depths of lagoons. The new aspect of this theory postulates a recent lowering of sea level, by about two meters, which accounts for the nearly uniform height of coral islets that has so far plagued our discussion. This theory gives us a general explanation of reef islet formation, but unfortunately, it cannot be applied to all cases seen in the field. The problem probably lies in the fact that, although glacial control is fairly uniform all over the world, absolute subsidence or emergence is not. No theory has yet been evolved that can be applied directly to all cases and, in the final analysis, I see no reason why we should expect to find one.

Micronesia is a somewhat arbitrary subdivision of Pacific Oceania, covering an area approximately equal to that of the United States. The Marshall Islands in the east are atolls. These islands fit well Kuenen's glacial controlled subsidence theory. Here reef flats are cut by fissures, strewn in places with delaminating limestone, and they support patches of old reef basement in testimony to a recent grander elevation. The windward reef islets of Majuro atoll appear to be in the process of being driven back away from the reef front, leaving the reef flat in their wake. Evidence of destruction is clear, but evidence for current subsidence is not. One gets the feeling that these reefs, since their recent relative emergence, have remained fairly static. The awe-inspiring thing about atolls is the realization that they represent the locations of huge

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submarine mountains that once raised their volcanic peaks high above the surface of the ocean and that the remains of these peaks now lie perhaps as much as 1000 meters beneath the coral limestone under one's feet.

Moving westward from the Marshall Islands we encounter the rather heterogeneous assemblage called the Caroline Islands. The eastern half of this group contains several high islands in varying stages of subsidence, as well as atolls similar to those seen in the Marshalls. Ponape is the largest of the high islands. It has a very shallow lagoon and poorly developed reef. It may be stretching the point a bit but Ponape appears to have little more than a large fringing reef, the type one would expect to see relatively early in the history of an island slowly settling into the ocean. That the island has subsided recently is clear for drowning valleys and islets are numerous.

Truk differs from Ponape in having a well developed encircling reef and deep lagoon. The lagoon is more than 45 miles across; seven substantial high islands and a larger number of smaller coral islands dot its surface. If one could pluck out the lagoon islands, Truk would take the title of being the largest atoll in the world. Evidence for subsidence is seen in numerous drowned valleys. It would appear that the forces of subsidence are active now for coconut trees are commonly seen growing below the high tide line. Some are dying and some have fallen out into the water.

There are both high and low islands in the Western Carolines, as there were in the eastern Carolines. The high islands however show signs of recent emergence. In the Palaus the lagoon is dotted in areas with small steep faced islets of limestone, indicating a lower level at which these islands once stood. Angaur, a little south of Palau, is a limestone island which represents an entire atoll raised above the level of the sea.

Moving north and east of the western Carolines to the Marianas one is immediately impressed by the evidence for emergence. Guam in this group has a tier of sea terraces, the limestone cliffs of which may rise as much as 100 feet in a single step. The great plateau, which forms a large portion of this island, was clearly produced by the planing action of the sea.

The Micronesian islands described here tend to fall into the bands or zones described by Darwin. The Marshalls are definitely an area of net subsidence, while the Carolines seem to be in an intermediate zone. The Marianas have undergone considerable emergence, at least in fairly recent time. Whether small oceanic islands are going up or down would seem to make little difference towards their eventual fate, for, barring another age of volcanic mountain building, they appear doomed to being reduced to the level of the sea.

References:

- Daly, R. A., 1910. "Pleistocene glaciation and the coral reef problem", Amer. Jour. Sci. ser. 4, 30:297-308
- Darwin, Charles, 1839. "Journal of researches", Facsimile reprint of the 1st ed. Hafner, New York-London, 1952.
- Kuenen, Ph. H., 1950. "Marine Geology", Wiley & Sons, New York.

DISTRIBUTION OF CONUS
ON CLIPPERTON ISLAND

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Observations on the distribution of species of the genus Conus outlined below were made during two University of California Scripps Institution of Oceanography expeditions to Clipperton Island in cooperation with the International Geophysical Year program. The island is a remote coral atoll, belonging to France, located about 670 miles southwest of Acapulco, Mexico. A first visit was described briefly in a talk before the 1958 meeting of the American Malacological Union, Pacific Division. (Allison, 1958). A second visit, following that A. M. U. meeting by several weeks, was far more extensive in preparation, in duration, and in scope of biological and geological studies attempted. SCUBA diving equipment, successfully employed within the protecting mesh of a swimming cage, permitted many hours of under water collecting and observing; this part of the 1956 efforts was disrupted by aggressive sharks. Although dives were made to a maximum depth of 130 feet, the adequacy of data from below about 60 feet is limited by the relatively brief duration of the few deeper dives.

Clipperton Island is an unusual atoll or, more correctly, near-atoll. An oval rim with a maximum dimension of $2\frac{1}{2}$ miles completely encircles a deep almost fresh-water lagoon. Clipperton Rock, a 70 foot high remnant of the volcanic foundation, offers the only break in the island's otherwise uniformly low profile. The low rim of coral debris and derived rock forming the remainder of the island varies between 150 and 1200 feet in width.

A generalized profile across the outer portion of the island and the adjacent subtidal area can be summarized as follows:

Beach (and beach rock) - slope and width variable as functions of coarseness of coral debris of which they are composed.

Reef flat - several hundred feet wide intertidal area formed by growing coral and coralline algae; the shoreward surface consists chiefly of coral patches and intervening coral sand, the seaward surface (slightly raised at outer edge) chiefly of coral and algae (both coralline and non-calcareous forms).

Reef front - gentle slope, cut by deep grooves, off outer edge of intertidal reef flat to a depth of about 20 feet.

Submarine terrace - several hundred feet wide with very gently sloping surface from a depth of about 20 feet outward usually to a depth of 40 to 60 feet; its outer edge is the major area of coral reef growth.

Outer slope - 40° to 60° slope off outer edge of submarine terrace. Five species of Conus have been collected and observed living on the reef flat and off shore.

Conus tiaratus Broderip in Sowerby, 1833 - especially common on inner portion of reef flat as the dominant Conus; less common on outer, more exposed portion of reef flat; not found off edge of reef flat.

Conus ebraeus Linnaeus, 1758 - common on outer portion of reef flat, particularly around locally scattered boulders, and out to edge of submarine terrace; less common on inner portion of intertidal reef flat; not seen in deeper water off outer edge of submarine terrace.

(continued)

Conus chaldaeus Roding, 1798 -
distributed the same as
C. ebraeus.

Conus purpurascens regalitatus
Sowerby, 1834 - most common
partly buried in sand and other
coral debris shoreward from vig-
orously growing coral along outer
edge of submarine terrace; not
seen deeper; rarely found near
outer edge of intertidal reef
flat.

Conus diadema Sowerby, 1834 -
occurs abundantly on submarine
terrace and very rarely as far
shoreward as outer edge of
intertidal reef flat.

Occurrences of dead shells on
Clipperton Island beaches reflect the
preferred habitats of the five species
of Conus. Shells of the three reef
flat species, often only slightly worn,
are common on all of the beaches. The
two offshore species, Conus purpurascens
regalitatus and C. diadema, appear only
as rare beach-worn specimens in collec-
tions from the 1956 expedition. Large
numbers of these two species, however,
were strewn across a portion of the
island devastated by a severe storm
which struck sometime during the inter-
val between the 1956 and the 1958 visit
making abundant fresh shells available
in the later collections.

Biogeographical relationships of
shallow marine invertebrates found on
Clipperton Island have been a source
of much of the interest manifested in
that remote spot. (Hertlein & Emerson,
1953 and 1957). The biological economy
and, in fact, the development of the
atoll have been accomplished with an
unusually small number of species.
Sparse experimental data and much
speculation suggest that most of the
mollusks and other larger shallow
water marine invertebrates represented
are those which have relatively prolonged
free floating larval stages: planktonic
larval stages of sufficient duration to

be carried by currents across the wide
oceanic deeps which separate Clipperton
Island from the two general areas of
origin. Those two areas are tropical
West America and the Indo-Pacific. The
nearest portions of America to the east
are about 670 miles distant while the
Marquesas and Hawaiian Islands, the
most immediate shoal areas to the west,
are no less than 1800 miles distant.

The duality of origins expressed
generally through Clipperton Island
invertebrates appears also within the
genus Conus. Three species, Conus
diadema, C. tiaratus, and C. purpur-
ascens regalitatus, are known only
from along the west coast of tropical
America and adjacent islands. The two
other species, Conus ebraeus and C.
chaldaeus, occur on the Galapagos
Islands and rarely (C. ebraeus) on the
mainland (Keen, 1958) but are
characteristic of the great Indo
Pacific Faunal Province. Clipperton
Island, in its remote eastern Pacific
location, could provide the "stepping
stone" which has allowed these two
species to cross the broad oceanic
barrier which separates the two shallow
marine faunal provinces.

Bibliography

- Allison, E. C., 1958 (Abstract)
Clipperton Island: east-
ernmost atoll of the Pacific.
- Hertlein, L. G., and Emerson, W. K.,
1953.
Mollusks from Clipperton
Island (eastern Pacific) with
the description of a new
species of gastropod.
San Diego Society of Natural
History, Transactions, vol.
11, no. 13, pp. 345-364, pls.
26-27.

(continued)

Hertlein, L. G., and Emerson, W. K., 1957.
Additional notes on the invertebrate fauna of Clipperton Island. American Museum of Natural History, Novitates no. 1859, pp. 1-9, text fig. 1.

Keen, A. M., 1958
Sea shells of tropical west America, p. 480. (Stanford University Press).

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FORCES WHICH AFFECT OUR FIELD TRIPS
by
Helen Hunt

Our field trips are taken at the time of a minus tide. When I first heard this I assumed that it meant a very low tide, as it does, also one that occurred with a certain regularity; but what the influences were that caused it and how it was determined I neglected to learn earlier. Therefore, some general information about the tides seems pertinent.

The periodic nature of tides results from the daily rotation of the earth about its axis, its annual revolution about the sun, and the moon's monthly revolution about the earth.

As far back as the Roman age, Pliny in 77 A.D. ascribed the tides to the action of the sun and the moon. But it was not understood. Sir Isaac Newton in 1687 propounded the first workable foundation for tidal theory based on his universal law of gravitation.

The moon is several hundred times nearer the earth than the sun and its force to produce tides is about $2\frac{1}{4}$ times as great as that of the sun, hence the tide follows the moon more closely than the sun.

The tide forces of the sun tend to bring high water or low water at the same time each day but those of the moon tend to come later each day by 50 min. The actual motions of the moon and the sun are quite complicated.

Their orbits are elliptical and instead of moving in the plane of the equator they are inclined to the equator, so that sometimes they are north and at other times south of the equator; hence the tide forces vary with the relative positions of the sun, moon and earth. The position of the local meridian in relation to that of the standard meridian, also differences in longitude and tidal curves, the vertical rise and fall of the tide and the horizontal flow of tidal currents, as well as the positions of the sun and moon must be taken into account for the computation of the tides.

In order to determine the heights and depressions of the tides a mean sea level must be ascertained and this defines a standard reference plane, or zero of the tide table, above and below which tides cause water to rise and fall. This averaged value is obtained from systematic observations of sea level taken at equal intervals over a long period of time along a given coast line.

There are three main types of tides: semidiurnal are those characterized by 2 high and 2 low waters each tidal day of 24 hrs. and 50 min. The diurnal tides are those which in the long run display but 1 high and 1 low each day. Mixed tides, which occur predominantly along the Pacific coast of the United States and near the merging of the Pacific and Indian oceans, display 2 high and 2 low each day but exhibit inequalities resulting from the combination of the first two. They may be aided or retarded by changes in the wind and in barometric conditions. In general with onshore winds or a low air pressure the heights of both the high and low waters will be higher than predicted, while with offshore winds or a high air pressure they will be lower. There are also seasonal variations that are noted at each station, as well as characteristics of the predominating tide at a particular place.

(continued)

Measurement of tidal heights used in establishing mean tidal planes are obtained by the use of instruments of 3 main types; staff gauges, box gauges, and pressure gauges. The first is a simple scale graduated to read in feet and tenths of a foot, attached vertically to a pier or fixed support in water so that the zero index lies below the lowest level of the tides. Readings are by visual or photographic means. The 2nd employs a box or pipe anchored to sea bottom to encase a float and protect it against the effect of choppy seas. Changing tidal heights are transmitted to the float through a small hole in the bottom of the case and differential readings of the position of the float are taken from the portion of the float staff extending from the top of the well. Revolving drums, with attached record sheets, may also be used which, rotated by clockwork, provide a graphical trace, both of the tides and the corresponding times. The pressure gauge variations in the height of tide above a group of rubber sacs located at a fixed depth in the water are indicated by a changing hydrostatic pressure as the water level changes. The pressure readings are communicated from the sacs below the water to the pressure gauge at the surface.

The range of the tides is the difference, to the nearest tenth of a foot, between the high and the low tide at a certain location on a given date. It may vary both for different locations and for high and low tides measured on different days at the same location.

At the time of the new moon, or conjunction, it and the sun are located in the same cardinal location in the sky but with the moon lying slightly above or below the sun (unless a solar or lunar eclipse is occurring). Accordingly, the moon is then invisible, lost in the brighter glare of the sun. Its gravitational force is then exerted along nearly the same line of action as

the sun and the two gravitational pulls tend to reinforce each other, to produce greater tide raising influences. This augmentation of tidal forces results in intensified high tides, known as spring tides, and diminished low tides, or minus tides. Similarly, at the time of the full moon, or opposition, when the moon is directly opposite the sun in the sky in hour angle, again the gravitational forces of the sun and moon unite along the same line of action to produce increased high and low tides, or minus tides. At the 2 intermediate lunar phases, when the moon is in the 1st. quarter or the 3rd. quarter phase in its revolution about the earth, the gravitational forces of the sun and moon are directed at right angles to each other in their pull on the earth and hence are naturally opposing in their tide raising action. The result is that the height of tides occurring at those times is diminished and the depression of low tides is less pronounced. The sun and moon tend to counteract each other and we have what are known as neap or scanty tides.

On the Pacific coast we have 4 tide horizons; uppermost beach, high tide region, mid-tide and low tide region, and the faunae found in the several zones have adjusted themselves to the conditions which the changing tides enforce. Zone 4, normally uncovered by minus tides only and extending from zero to $2\frac{1}{2}$ ft. at some localities, is the zone for the collector. Many middle horizon animals occur here also, but much of the population consists of animals unable to exist higher up and not so accustomed to the rhythm of the waves. This environment contributes a greater number of species than the sum of the other tidal levels. Hence, our field trips at a minus tide.

It is a simple matter to-day to secure a tide-table and we have progressed far in the analysis and prediction of the tides, but in earlier days it was not so.

(continued)

The U.S. Coast & Geodetic Survey have published tide tables for the use of mariners since 1853. At first these were a means which enabled the mariners to estimate the tides as their needs arose and were appendices to the Survey's Annual Report. Fourteen years later the 1st tables to give predicted tides for each day of the year were published and these gave the time and heights of high waters only, one part for the Pacific coast, the other for the Atlantic coast of the U.S. By 1896 the tables included the entire maritime world, predicting all tides.

The practical or non harmonic efforts are based in large part upon actual observations of tidal heights made at a net work of selected observing stations and are made by applying to the times of the moon's transit and to the mean height of the tide, the systems of differences to take account of the average conditions and various inequalities due to change in the phase of the moon and in the declination and parallax of the moon and the sun. This organization maintains for this purpose 84 tide measuring stations, 61 in the continental limits of the U.S. and 23 in our territorial waters. It publishes an annual volume, generally issued 2 yrs. in advance and in addition daily current predictions are published annually for a lesser number of reference stations and subordinate stations. These tide tables cover the Atlantic, Pacific and Indian oceans and the current tables cover the west coasts of North and South America and the Hawaiian Islands.

The U.S. Coast & Geodetic Survey also publish an Harmonic Analysis and Prediction of Tides. Wm. Thomson, known as Lord Kelvin, proposed the 1st harmonic analysis of the tides in 1867. This is based upon an assumption that the rise and fall of the tide in any locality can be expressed mathematically by the sum of a series of harmonic terms having certain relations to astronomical conditions. This mathematical figuration is reached by the use of a complex tide-predicting machine which utilizes

measurements made at the principal observation stations for solution by both the harmonic and non-harmonic assumption of tidal theory. Our navy acquired in 1954 a high speed electric computer capable of solving tidal circulations in all oceans, as well as intricate tidal currents, in the matter of a few days. Nineteen years of observations are required to complete an entire cycle of all possible solar and lunar variations. Some of you have scientific knowledge of the tides but for those of you who don't I hope this simple explanation of a minus tide has made it more understandable.

WHY RULES OF PRIORITY?

by

Dr. Rudolf Stohler
Dept. of Zoology
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In the first article of this series it was shown how much confusion in the naming of organisms had arisen through one means or another.

After the Swedish naturalist Linne (or Linnaeus) had, in the year 1751, called attention to the need of a unified system in applying names to animals and plants, a number of different systems were proposed. Linnaeus himself worked out a system, however, which has been generally adopted and is in use today. It may be said that our procedure in naming animals (and plants) dates back to January 1, 1758, because the classical work in which this method was started, was published sometime during the year 1758 and although the exact date of publication seems to be unknown, the first day of the year is considered, by general consent and agreement, as the date of the publication. While it might seem

that this really simple system would have been accepted immediately and universally, it took, nevertheless, over 130 years before a more or less formal adoption was worked out. At the first International Zoological Congress in Paris in the year 1889 a code, proposed by a French zoologist, was adopted. But still, this was not followed uniformly until at the fifth Congress, held in Berlin in 1901, the code which is now internationally accepted, was proposed.

It may be said that the International Code of Zoological Nomenclature is a living thing and as such keeps growing and changing. This is really a good thing but may - and sometimes does - lead to confusion. The most important changes which are made every time the International Congress meets are usually concerned with correcting errors and making the rules more precise and more readily understandable; although it must be admitted that a trained lawyer would probably have an easier time understanding all the rules than a zoologist might have.

It is unnecessary to trace here the historical development of these rules which we now must - and really prefer - to follow. We will try to discuss the rules under separate headings: first, as they affect the names given to animals by earlier authors and, secondly, as they affect the manner in which nowadays a valid name may be given to a newly discovered species.

The first rule applicable to older names (actually to both subheadings) is that they must be binominal for species and trinominal for subspecies. In passing we might remark that genus names are to be uninominal. Perhaps, before going further, we must examine what these terms mean. Binominal means simply that there are two similar things which are names; trinominal means that there are three names. In other words: the name of a species must consist of not less nor more than exactly two words, both of

which are names.

This sounds a little confusing, perhaps, if we say that a name must consist of two names. But it really is simple: a species is of course a certain group of individual animals; the species name is the name applied to that particular group of animals; and the species name consists of two words, the first being the name of the genus and the second of the particular group of individuals within the genus - the species. We will illustrate with an example. Linnaeus named the common toad of Europe Rana bufo. Rana is the genus name applicable to frogs and is the Latin name of frogs (ancient little Romans came home, showing proudly their jumping Rana to their Mom, no doubt!) and the word bufo is the Latin name for the toad. Thus Linnaeus, believing the toad to be a member of the frog group, called it in Latin the frog toad: Rana bufo! (we will use this interesting animal for other examples later on, it really gets amusing.)

Another important rule is that the first published species name which obeys this principle just mentioned is valid and cannot be changed ever. Even if it becomes necessary to transfer the animal, so to speak, into another genus, it still must retain the original species name. Our example: the toad is considered no longer as belonging to the frogs; an early writer decided that, and established for the toads the genus Bufo; he then called the common toad of Europe Bufo vulgaris. However, since Linnaeus work follows very strictly that rule mentioned first, the species name bufo must be applied to the common European toad and we therefore now call it Bufo bufo. (Later the plot thickens still more, just wait and see!)

All works which appeared before January 1, 1758, are considered as if
(continued)

they had never been written, at least in respect to the validity of the names contained therein. Any book, published after January 1, 1758, may have to be ruled invalid also, if the author did not consistently use just two words for his species names, even though he may have been doing the right thing by most of the species he described in his work.

A third rule, which is also of great importance in determining the validity of a name, is that the first published species name must have been accompanied by a definition or a description or an indication. This last word means simply that the species name must have been accompanied by an illustration or a very clear and definite citation of an earlier name which it is proposed to replace with the new name or a good bibliographic reference. It definitely does not permit the use of names given only on labels or included with specimens or mentioned in a letter or an unpublished manuscript.

In our next article we will discuss the rules applicable to names of newly discovered species published after January 1, 1931.

CLUB NEWS

Sunday, February 22, was another high high light in Club activities as we were the guests of Dr. Myra Keen, Assistant Professor of Paleontology and Curator of Malacology, at Stanford University, Palo Alto.

Thirty three members, some with their families and friends, were welcomed by Dr. Keen.

First on the program was the Mikimoto film of the Cultured Pearl Industry of Japan. A fact that many

may not have been aware of is that the irritant which is placed in the soft part of the oyster, or the nucleus of a pearl, is from our Mississippi River Mussel. In seven years time our Mussel contribution returns to the U.S. as a beautiful pearl. Dr. Keen's narration added greatly to one's knowledge of this fascinating and wonderfully successful enterprise.

Colored slides followed, illustrating the harvesting and selection of oysters for export to the U.S. Seven oyster spats must be on each oyster and they are carefully checked for accuracy. These are sent to the states of Washington and northern California for propagation.

We were then invited to see specimens in cases. In another room were cartons of identified shells and we were told: "take as many as you like". Small boxes, paper, and slips on which to copy the identifications were also provided.

Coffee and cookies were served to conclude an afternoon of gracious and generous hospitality by Dr. Keen and one that those who attended will long remember with deep appreciation.

The AMUPD meeting will be held in Redlands, California, from July 9th to July 12th: the National Convention to be held in Haverford, Pa., from June 30th to July 3rd.

Shells from Mexico and Africa were give-aways from Helen Burton at our Jan. meeting. Hazel Jeschien displayed beautiful Japanese specimens, while Ruth Bancroft's were very fine specimens of California shells.

Lucille Zeller's Cone shells shown at our March meeting provided added interest to Dr. Paul Saunder's fascinating and beautiful colored film on Conus feeding.

PERSONALS

On March 2nd Helen and Alice Burton left on a six month's air-plane trip to parts of the world they haven't seen.

No personal shell collecting this time, only by way of purchase. Their itinerary includes twenty different cities; also their baggage included ten pounds of film, we can anticipate seeing some beautiful pictures with a "sparkling Burton" narration upon their return.

A recent card received from Helen says in part: "We had two good days in Japan and are now in Taipei which we love - mountains, flowers, peaceful, good fruit, friendly people".

Mr and Mrs. Steininger were present at our Stanford meeting, also that of March 3rd, after a long absence due to illness. It was good to welcome them again.

Another member we were glad to see was Mr. Ney, who reported that Mrs. Ney was rapidly recovering from an operation, so we may look forward to her attendance very soon.

Ray and Loreen Summers were recent hosts to a small group of club members who enjoyed seeing what is said to be the finest private collection of Cypraeas in the United States.

The February 27, 1959, publication of the California Academy of Sciences, San Francisco, California, describes "Two New Species of West North American Marine Gastropods", by Dr. Rudolf Stohler of the Department of Zoology, University of California, Berkeley.

These were identified and named by him as Astraea (Uvanilla) rupicollina and Macrarené coronadensis.

EXCHANGES

Hazel Jeschien has made satisfactory exchanges with the following and has many more names on file:

J.W. Pettingell, 311 Belleview Blvd.,
Belleair, Clearwater, Florida.
Emma Rush, 621 Northridge St.,
Greensboro, North Carolina.
E.D. Latham, 7 Coleh So. Ave, Hapier
Hawke's Bay, New Zealand.
Mrs. C.P. Morgan, 8 Poynder Avenue,
Fendalton, Christchurch, New Zealand.
Mrs. Freeman, 55 Grendon St., No.
Mackay, No. Queensland, Australia.

Letters received from:
Mrs. James Rutledge, 7723-73 Avenue,
Edmonton, Alberta, Canada.
Mrs. Frank L. Pauley, Box 70,
Fort Amador, Canal Zone.
Also a letter from Angel Antonio Gior-
daro, Avda. Gral. Artigas, Sarandf-
Florida, Uruguay, who would like to
exchange stamps for shells.
The letters are on file in our library
for particulars.

THE VELIGER

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Original papers dealing with any topic in relation to mollusks from the Pacific Region (in the broadest sense) will be considered for publication. Dead lines for April no., Feb. 15th; for July no., May 15; for Oct. no., August 15; for Jan. no., Nov. 15th.

Editor: - Helen Hunt, 2437 Shattuck Avenue, Berkeley 4, California
Phone: - Thornwall 8 - 1057

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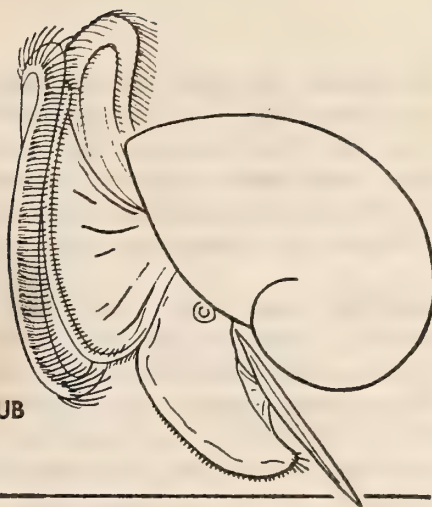
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THE VELIGER

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Volume 2

July 1, 1959 - April 1, 1960

Foreword to Volume Two

It seems to be a truism that Forewords are always written at the time when the paper or book is finished. This foreword is, in this respect at least, no exception. In fact, it could not have been written before volume two was completed, because we could not possibly foresee the course of events as they developed in a more or less orderly fashion.

Looking back over the past year, it is gratifying to see how rapidly the journal has developed and reached its present stature. Less gratifying is the financial picture which owes its gloomy aspect to the unexpected growth of the quarterly. It is hoped to wipe out the present deficit in due time, partly through donations to our Veliger Operating Fund and partly through other income. Such donations, incidentally, are deductible from the U. S. Income taxes, since the publisher of the Veliger, the Northern California Malacozoological Club, is incorporated in the State of California as a Non-Profit Educational Corporation.

That the deficit is not much greater than it actually is, can be ascribed only to the fact that so many individuals have most generously contributed of their time and talents. It seems fitting that a word of thanks be extended to these individuals here, so-to-speak publicly, for their part in making a truly scientific contribution.

Stencils for mimeographing have been cut, principally by three individuals: Mrs. Lea Schult (Vol. 1, No. 1), Mrs. Muriel Olson (Vol. 1, Nos. 2, 3, and 4), and Miss Heidi Stohler (Vol. 2, Nos. 2, 3, and 4). Much of the art work has been contributed by Mrs. Emily Reid. All letterpress work was done by your editor. Another important contribution which is apparent only indirectly is the valuable advice given freely by various members of the staff of the University Press, notably Mr. Earl Gustafson, Mr. Louis Rengel, Mr. John Schoen, and Mr. Charles Peckham. Dr. Phyllis Kutsky has undertaken the continuing task of indexing the journal and it is planned to publish at five-year intervals a cumulative index to the various species. The accompanying index of authors and titles to Volume Two is a first sample of her work. Still further behind the scenes are many people, the officers and members of the Northern California Malacozoological Club who through their farsightedness have helped to make this venture possible. To all these people, named and unnamed, go the heartfelt thanks of

The Editor.

Berkeley, April 30, 1960

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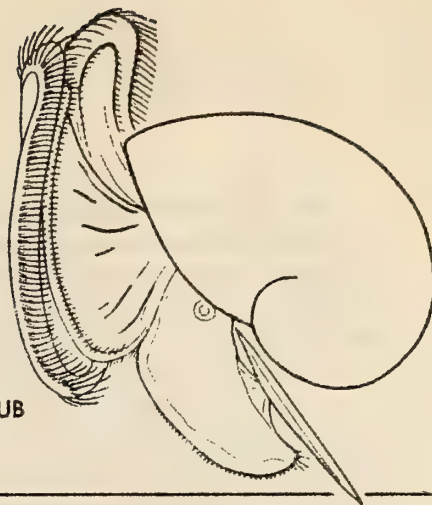
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THE VELIGER is open to original papers pertaining to any problem concerned with mollusks from the Pacific Region.

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SOME SIDE NOTES ON "SEASHELLS OF TROPICAL WEST AMERICA"

by

Dr. Myra Keen

Stanford University, California

(Plate 1)

All the while I was writing my book I kept meeting problems that I could not properly solve. Not all of them could be merely discussed and left open, and on many I had to make arbitrary decisions. The sequels to some of these point up a moral on the matter of type collections.

For example, the problem of the pelecypod group Tedinia Gray, 1853 ("On a new genus of Anomiadae", Proc. Zool. Soc. London for 1851, pp. 197-8), Gray gave no figure for the type species, T. pernoides, and his description was not very informative. He thought the shell might have come from California and that the distinguishing feature of the genus was an additional muscle scar under the hinge. A few years later Carpenter in the Mazatlan Catalogue, discussing the holotype of T. pernoides, said that this scar was probably a peculiarity of growth and that "There were so many lines traceable on the inner surface that a naturalist so disposed might have arranged almost as many muscles as he thought desirable." He believed he had specimens from Mazatlan representing the same thing, but -- to be on the safe side -- he described them as new under the name Placunanomia pernoides. As his material also was left unillustrated, both names remained enigmatic. I requested a photograph of Gray's type, which is in the British Museum. A good one was sent, but it still left me baffled. The specimen was evidently pathological, and I could not recognize it as anything I had seen. Finally deciding it was a distorted member of the pearl-oyster family, I used the name (but fortunately not the figure) for a form that seemed to need it. A trip to London to attend the International Congress of Zoology after my book was in page proof but not yet ready for printing gave me a chance

to see the actual type specimen. Even then, light dawned only gradually, and not until the third inspection did I finally become aware that this was the form we had in the Stanford Collection labelled as Pododesmus foliatus, from southern California. It was indeed an anomiid, not a pteriid. Inspection of the type of P. foliatus, from Ecuador, showed that our label was grossly in error, for the true P. foliatus instead of being irregular in shape and dark brown in color is smoothly lenticular, with a brown patch in the center of a white shell. Wondering why such a mistake should have been made, I looked up the original figure in Reeve's Conchologia Iconica and concluded that he must have switched specimens, for his figure shows a shell that is neither of these two. No wonder American workers, guided only by this incorrect figure and the puzzling description, had arrived at such a determination! The type of Carpenter's Placunanomia pernoides, though a less distorted specimen, proved to be, in my opinion, conspecific with Gray's.

Genera of the Anomiidae are divided on the basis of the position and number of adductor and retractor muscle scars, the shape of the ligamental area, and presence or absence of crural ridges along the hinge margin (see Plate 1). Anomia proper has an opening in one valve that in other genera may be variously modified. This opening in Pododesmus is large in West American species but small or even sealed over in the type species, a Caribbean form. (I suspect, in fact, that we may be wise to re-adopt Monia as a subgeneric name for P. macroschisma and P. cepio, to emphasize their difference from the type of Pododesmus s.s.) The ligament of Pododesmus is elevated on a sort of pedestal in the valve that has the

opening. Placunanomia has the opening completely closed, although, as in Pododesmus, a pad of rough chitin on the inside of the shell marks its position, a groove joining it to the dorsal edge of the shell. The hinge has two heavy crural ridges. Both Pododesmus and Placunanomia show one less muscle scar than Anomia - - 2 instead of 3.

The type specimen of Tedinia pernoides proved to have the muscle scar pattern and ligamental pedestal of Pododesmus, with the opening sealed over, at least in the adult, and I decided that Tedinia should rank as a subgenus, differing in the smaller size, irregular shape, and dark color of the inside. Though my discovery came in time so that I could straighten out the error I had almost made, I necessarily had to make the needed changes in the page proofs very brief, without adding any discussion.

Before I went abroad I had been told that Carpenter's type specimens were not available, but in this I had a pleasant surprise. They were at the British Museum of Natural History, all together in a special cabinet, and Mr. Peter Dance, the assistant actively working on the collections, was eager to have someone study them. My time was so taken up with other work that I could examine only the larger forms and had to pass over entirely the dozens of glass slides on which Carpenter himself had glued the smaller shells. In the very last drawer I saw a specimen that was a twin to my own holotype of Aspella perplexa! This was the type of Muricidea terinaceoides var. indentata Carpenter, 1857, which no one had ever succeeded in recognizing from the description. I had disposed of this name in my book by suggesting that it might take the place of the homonymous Murex fimbriatus A. Adams (species no. 341), which, though it had been illustrated, also was an unrecognized form. Standing there, with the shell in my hand, and re-reading Carpenter's description, I was chagrined at my failure to interpret his words, for his description fitted my Aspella much

better than it did the other form.

These two experiences point up the value of type collections. How many problems can be solved by a simple study of a type specimen! I cannot express too strongly my admiration for the British in the way they have kept this priceless material during the past century, through two world wars and many changes of administration. Faithfully and well these Museum people have preserved the shells, until we had developed the interest and facilities to study them, and will continue to keep the material for the use of future students. Under the Principle of Conservation that some individuals are trying to write into the International Rules of Nomenclature, we could set aside any names (and therefore types) that have not been used in the literature for the past 50 years. But how much more satisfying it is to be able to credit the men who did the early systematic work with the names they bestowed. We are finding enough new things to describe without burdening our papers with added names for forms once recognized but since overlooked.

A few comments on the Muricidae seem also in order. This was the first family to attract my attention when I started serious work back in 1934. In spite of long interest, I still am unsatisfied with the classification, and I am irked at several errors of judgment in my book. For example, I should have treated Centrifuga as a subgenus of Pterynotus. As Dr. S. S. Berry has since pointed out to me, the type species is very close to P. swansoni (he thought P. centrifuga might even be the juvenile form, but a growth series of P. swansoni recently collected by Mr. E. C. Stiles refutes this). A lapsus in the description of P. swansoni on page 358 was noticed by Mr. E. P. Chace: I should have compared it to P. carpenteri (Dall, 1899), of which P. petri is a synonym. The suggested synonymy for P. swansoni also has proved to be incorrect, for Dr. Donald Shasky has a



Figure 1

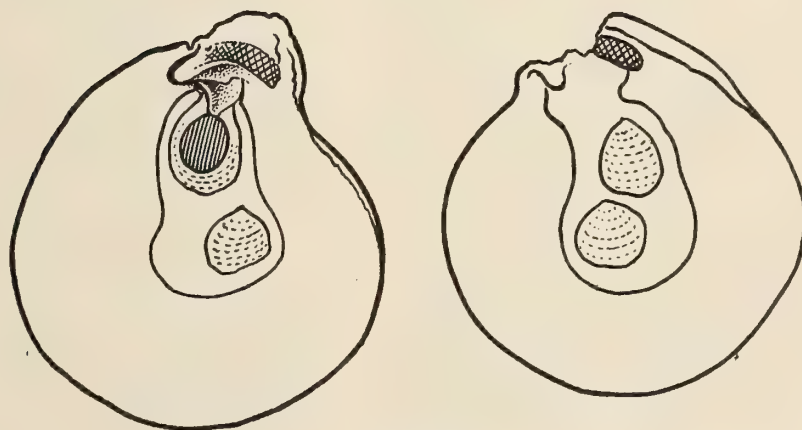


Figure 2

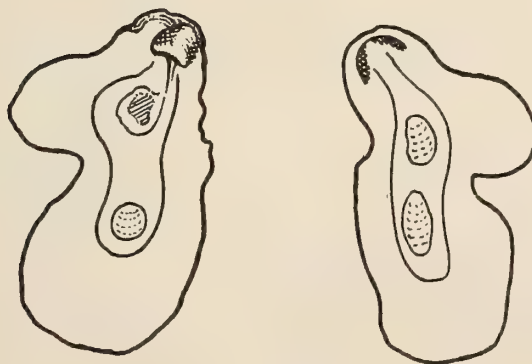


Figure 3

Interiors of three type species in Anomiidae.

Ligament is shown by cross-hatching, the byssal plug by parallel lining. Figure 1, *Placunanomia cumingii* BRODERIP. Figure 2, *Pododesmus rudis* (BRODERIP). Figure 3, *Tedinia pernoides* GRAY.

good P. inezana from the Guaymas shrimp boats. It proves to be entirely distinct from P. swansoni and closer to P. piniger, but a study of the type specimen of the latter must be made before the relationship can be satisfactorily settled.

Dr. R. Tucker Abbott has recently ("The marine mollusks of Grand Cayman Island, British West Indies", Monog. Acad. Nat. Sci., Philadelphia no. 11, 134 pp., 5 pls., Dec. 1958) questioned the advisability of such subdivisions as Phyllonotus, Hexaplex, and Muricanthus on the ground that boundaries between the groups are nebulous. To this I would reply that although such lines are a perennial problem in all systematics, sometimes when they seem tenuous it is because faulty criteria are being relied upon or the division is attempted on single rather than multiple characters. Geographic distribution is a good test of validity. If the groups separated on the basis of morphology fall into a geographic pattern, one feels more assurance that the division is a natural one. It may be in the Muricidae that we are trying to crowd too many species into too few subdivisions and that with a more careful survey of world Muricidae we would find that proposal of additional generic and subgeneric divisions and a redistribution of known species therein would make for a sounder classification. This is more than a theoretical question, as I shall show in a moment. Abbott's discussion had to do with the renaming of a homonym, Murex imperialis Swainson, 1831. As he correctly pointed out, this West Indian form closely resembles our Hexaplex regius, but he did not follow through to show that it is thus the first Hexaplex to be recognized in the Caribbean. In recent years M. imperialis (now M. margaritensis Abbott) has been synonymized with M. pomum Gmelin, 1791. The latter, a much more abundant shell than the former, therefore, has supplied for many of us the concept of Phyllonotus (see, for example, my statement — now erroneous — on page 352 that the type of Phyllonotus has 3 varices). As Abbott

has convincingly shown, these are not synonyms, but two separate species, the one with 3, the other with $4\frac{1}{2}$ to 6 varices. I would even suggest that the two may fall in distinct genera. The unhappy consequence of this view, however, is that as M. imperialis was fixed as type of Phyllonotus Swainson, 1833, allocating it now to the group Hexaplex throws Phyllonotus into the synonymy of Hexaplex, which was named by Perry in 1811. The group of Murex pomum is then left without a divisional name other than Murex. I use the word "group" intentionally, for a Pacific analogue of this Atlantic species has recently come to light, and I have been asked to describe it by Dr. Donald Shasky, the first person to get more than a single specimen in the West Mexican area. I am now working on the problems it presents, of which the generic name is an important one. For informal or conversational purposes, Dr. Abbott's solution — to disregard all divisions and speak only of Murex — is convenient, but it is a course not in harmony with systematic trends, for we have, with the years, learned to make more and more precise discriminations, and we signalize the groups that result with special names. I therefore suspect that I shall end by reluctantly proposing another new generic name in Muricidae.

The TRILOBOPSIS on the Trinity River

by

Robert R. Talmadge
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The lower Trinity River, in extreme northern California, furnishes collecting localities for three subspecies of Trilobopsis loricata (Gould), a small polygyrid snail. The external appearance, and the ecological niches, inhabited by its three subspecies are so distinct that perhaps further study of the anatomy would justify elevating them to specific rank.

Geologically, the lower Trinity River traverses a broken mass of the western Klamath Mountains. In this area the predominant rocks are schists, especially so along the river where this species is found. Due to faulting and elevating, steep talus slopes are quite common, often with a heavy covering of vegetation. Many of these areas have become stabilized and overgrown. The forest duff has accumulated between the rocks, giving a superficial appearance of a smooth, yet steep slope. There is one known igneous extrusion, a blanket-like layer, and numerous areas of serpentine and serpentine clays.

The area under consideration covers the lower sixty miles of the Trinity River, from the vicinity of Big Bar, Trinity County, to the junction of the Trinity and Klamath Rivers at Weitchpec, in Humboldt County. As these small snails were found to be plentiful in certain areas and ecological situations, yet lacking in others, a brief study was made to learn what constituted the local ecological biome. The following notes are the result of that project.

Trilobopsis loricata sonomaensis (Hemphill): California, near Healdsburg, Sonoma County, Type in California Academy of Sciences. Mr. Allyn G. Smith, of the California Academy of Sciences, compared the Trinity River specimens with the type. Although not agreeing in all details, these specimens are closer to the sonomaensis than to the loricata s.s., or any other of the subspecies. In fact, the populations differ from locality to locality along the river, indicating a series of clines. There is no contrasting feature that is strong enough to be considered as the basis for a separate subspecies. This is the common race found along the river and found in several similar ecological situations.

Dry talus: The talus may be divided into two types, exposed and overgrown, but in both types there is a very good drainage system. The recent slopes have little

or no vegetation on them, and the upper areas are still in movement. Only at the foot is there any degree of stabilization. Here the rocks are imbedded somewhat in gravel and what little organic debris is found in between the broken rock. It is under these lower rocks that the Trilobopsis are found early in the season. Normally they are attached to rocks and are discovered when these are rolled over. As the season progresses and the region becomes dryer, these little snails seek the deeper crevices and work back into the base of the cliff.

Some of the slopes have become stabilized, and now support a rather heavy growth of timber. The duff nearly conceals the rocky slope. To locate the Trilobopsis in such a situation, it is necessary to hunt for exposed rocks and start turning them over.

In the old mine scars where the gold bearing gravel was washed away, one will find piles of rounded river boulders where they were separated from the gravels by "Grizzlies". For some reason or other, the Trilobopsis do not live in such piles. However, where the bedrock was exposed, the schists have weathered. This weathering has created layers of shingle-like flat rocks. Under these the Trilobopsis are often found in great numbers.

On some of the very old stabilized areas, this snail has forsaken its rock habitat and may be found on the underside of down logs. However, in all cases, it appears that the snail desires a dampish, yet well drained habitat, with a certain amount of duff to furnish food.

Trilobopsis loricata perforata Pilsbry: California, near Healdsburg, Sonoma County, Type in Academy of Natural Sciences, Philadelphia. This race caused Pilsbry some confusion. Hemphill sent out the material separately, but Pilsbry questioned the occurrence of two subspecies so close

together. It was thought that perhaps this race was an extreme variant of the T. l. sonomaensis. However, habitat findings on the Trinity River indicate that both races may be found side by side, and such a situation might have occurred in Sonoma County. Along the Trinity and some of its small tributaries are found small springs or seeps. It was startling to find this snail living under rocks in the wet areas. In some cases the rocks actually were situated in the water; the snails clinging to the undersides just above the water level. So far the collecting stations have been limited, and consist of two tiny seeps on the Trinity River between Big Bar and Del Loma in Trinity County, and on Big French Creek, a tributary situated between the two populated areas referred to above. In contrast to the well drained situation desired by the T. l. sonomaensis, the T. l. perforata seems to thrive on wetness. Immediately adjacent to the seeps on the river are found populations of the first race, and no trace of intergradation could be observed.

Trilobopsis loricata nortensis

Berry: California, Ternah, vic. Requa, Del Norte County, Type in Berry Collection, Redlands.

The lower Klamath River race has not been found on the central Klamath River up to this time. Rather, the Klamath populations upstream and some distance

downstream all appear to be closer to the T. l. sonomaensis. There is, however, a small population inhabiting an igneous blanket, a few miles up the Trinity River from its junction with the Klamath River at Weitchpec. This volcanic extrusion is very loose and broken, and quite dangerous to cross. There is some moss, fern, and other forest debris scattered about this slide area. The forest is starting to encroach onto the loose rock, but very slowly due to lack of humus.

It was therefore rather interesting to note this race of the small Trilobopsis, living not in the semistabilized sections of the moss, but on the barest, least stable portions. The snail has always been found singly, and usually in rather deep open crevices.

What is the answer to this situation? Do we have three ecological races; or do we have three species? The answer may be known some day, when detailed anatomical work has been completed by persons having more knowledge of the anatomy than the writer.

In contrast to the other two races mentioned, the Trilobopsis loricata nortensis appears to prefer an open dry rock formation. Again, close by one may find the omnipresent T. l. sonomaensis, but as mentioned before, in stabilized talus.

Notes on California Oysters

by

Dr. Lee G. Hertlein

California Academy of Sciences, San Francisco

(with Plate 2)

Oysters are of interest to man because of their importance as food, as objects of biologic studies and because of the value of their shells in industry and commerce.

These bivalves have existed in

the waters of California for millions of years. A giant extinct species, Ostrea titan Conrad, well known to geologists, attained a length of 457 mm. (18 inches). At some localities in the coast range this huge, thick-shelled oyster occurs in abundance in

beds of late Miocene age.

Oysters have been an important source of food for the inhabitants of California from the time of the American Indians to the present day. Myriads of empty shells of Ostrea lurida occur in shell middens in the vicinity of marine waters.

The relative abundance of this species in relation to the stratigraphic sequence in some of the kitchen middens has aided anthropologists (see Greengo, 1951) in interpreting the cultural sequence in shell mounds in the San Francisco Bay region. Ostrea lurida does not flourish on a muddy bottom; ecological conditions resulting from changes in sea level sometimes formed a favorable, at other times an unfavorable habitat for this species.

Extensive beds of shells of this oyster on the bottom of the south arm of San Francisco Bay have become an economic asset in the manufacture of cement.

There are only two native species of oysters in California waters, Ostrea lurida (including three named varieties) and Ostrea conchaphila, the latter occurring only in the southernmost portion of the state. At least three species have been introduced into San Francisco Bay for commercial purposes, two of which, the Virginia oyster and the Japanese oyster, are cultivated at the present time in neighboring bays but not in San Francisco Bay.

Ostrea lurida Carpenter

Plate 2, Figures 1 and 2 (typical);
3, 6, 7, 8, 9, 11 (varietal forms).

This is the "Native oyster" or "Olympic oyster", which ranges from Sitka, Alaska (57° north latitude) to Cape San Lucas, Lower California, Mexico, usually in bays and lagoons from low tide to 71 meters (39 fathoms). It attains a length of about 75 mm. The lower (left) valve, shallowly concave,

may be attached by a small area beneath the umbo or attached by the entire surface. The upper (right) valve is flat and fits into the slightly raised margins of the opposite valve. Several small denticles are present along the margin just anterior to the hinge area. The interior is white, or, along the margins or sometimes over much of the interior, olive-green or sometimes with blotches of reddish or purplish-brown. The exterior of the valves is yellowish-brown, often striped with yellow or purplish-brown. The shell is extremely variable; a typical specimen from Shoalwater Bay, Washington, is illustrated in figures 1 and 2. The multiplicity of forms assumed by this species has led to the proposal of names for three of them, the types of which have never been illustrated (see Palmer, 1958, pp. 67-69).

Ostrea lurida is monoecious (both male and female). It is estimated that 250,000 to 1,000,000 larvae may be extruded into the water, in one season, where after a short period of free-swimming they attach to rocks or anything solid and apparently are partial to iron. They require marine or brackish water but must be kept off muddy bottoms. Some young individuals are reported by Coe to grow as much as 28-37 mm. in 16 weeks.

This oyster occurred in waters of Washington in great abundance and the meat was of such excellent flavor that it was in great demand and as early as 1851 it was shipped from Willapa Bay to San Francisco. Unrestricted fishing of the species in that region led to depletion from which, according to Kincaid (1951), it has not recovered to the present time.

Ostrea lurida was introduced into Hawaiian waters in 1893 but it survived there only a short time. Live specimens have been transplanted to Japan and their development observed by Japanese scientists.

Ostrea lurida forma expansa Carpenter (see Palmer, 1958, p. 67) was originally described as flat, attached by the whole surface of the lower valve, rounded or winged in shape and grading into O. conchaphila. Mrs. Palmer mentioned that specimens which she examined and which Carpenter identified with this form are "flat, thin, and have a yellow hue."

The valve illustrated in figure 3 was attached by its entire lower surface. The shell is fairly thin and the color of the interior is white and olivaceous, the exterior is striped brown and yellow. This specimen evidently is approaching the form expansa. In the Henry Hemphill collection in the California Academy of Sciences there are flat, rounded, and striped specimens which present almost every gradation into O. conchaphila. Some of these labeled by Hemphill as variety expansa are clearly referable to O. conchaphila.

Ostrea lurida forma laticaudata Carpenter (see Palmer, 1958, p. 68) was described as "Purple, winged, waved: denticles near hinge. Passes towards Palmula." The shells illustrated in Figures 7 and 8 were, according to H. N. Lowe (oral communication), from the original lot upon which Dall based his record of O. palmula from San Pedro, California. The lower valve is cupped, the margin is serrated, and denticles are present along the margin just below the hinge. The color of the margin interiorly is olive-green rather than dark blue as in the true tropical O. palmula with which it probably intergrades. In addition to the difference in color, O. palmula often has a more deeply concave lower valve and denticles often are present along most and sometimes all around the margin.

Ostrea lurida forma rufoides Carpenter (see Palmer, 1958, p. 68), was originally described as "Passing towards Virginica, jun. Thin, with umbos hollowed; reddish in scar-region.

Also fossil." The specimen from San Quintin Bay, Lower California, here illustrated in figure 11 bears a general resemblance to juvenile forms of O. virginica. The interior of the valve is blotched with reddish-brown. This specimen would seem to approach Carpenter's form rufoides.

Ostrea conchaphila Carpenter

Plate 2, Figures 4 and 5

The shell of this species is flat, often rounded, rather thin, with denticles along the margin below the hinge. It ranges from San Diego, California, to Panama. The type specimen illustrated by Hertlein and Strong (Bull. Amer. Mus. Nat. Hist., Vol. 107, Art. 2, pl. 3, figs. 29, 30, 1955), came from Mazatlan, Mexico. The interior is light olivaceous-green and white, the exterior is purplish-brown with yellowish radial stripes. The specimen from San Diego here illustrated is 50 mm. long and appears to be referable to O. conchaphila.

Introduced Species

Ostrea corteziensis Hertlein

This is the "Guaymas oyster", well known in the Gulf of California. The shell is similar to that of Ostrea virginica but the muscle impression is totally white or it may be streaked with purplish-brown but is never black or blue-black as in the eastern oyster.

An attempt to introduce the present species into San Francisco Bay (Townsend, 1893, p. 361) failed chiefly because the temperature of the water is much lower than that of its natural habitat.

According to Bonnot (1935, p. 66) oysters from Mexico were shipped to San Francisco in 1868 and sold on the pier for 25 cents each. Bonnot (1935, p. 72) also mentioned that a Mexican oyster "O. veatchii" was introduced

into Elkhorn Slough in 1929. *Ostrea veatchii* Gabb is an extinct Pliocene species but a similar species, *O. angelica* Rochebrune, lives in the Gulf of California. Presumably the oyster mentioned by Bonnot was *O. corteziensis* but I have not seen specimens. The transplantation apparently was a failure.

Ostrea gigas Thunberg

Plate 2, Figures 12 and 13

This is the "Japanese oyster" or "Pacific oyster" of commerce which apparently has been cultivated in Japan for nearly three hundred years. According to Kincaid (1951) who has made an extensive study of this species, it was introduced into the waters of Washington in 1902, but its commercial development did not take place until about 1928. This species also received extensive study by Chapman and Esveltdt (1943) who stated that it was introduced into California about 1932.

Commercial beds of this species are now found at Drake's Estero, Tomales Bay, and Morro Bay, California, as well as in Oregon, Washington, and British Columbia. The value of the oyster crop of the Pacific coast annually, mentioned by Kincaid (1951, p. 3) was approximately

six million dollars. This species also at times has been introduced into other localities including Humboldt Bay, Elkhorn Slough, and, for experimental purposes, even into Salton Sea (H.G. Orcutt, oral communication). Commercial beds are replenished by importation of seed oysters from Japan where the species is reported to live from the intertidal zone to a depth of 30 meters.

The shell of *Ostrea gigas* is variable. Typical forms are rather smooth and flat, but others bear strong radial ridges or flutings and widely spaced concentric lamellae, as in the form *laperousii* Schrenck shown in figures 12 and 13. In Japan the shells from Sendai, in the northern region, are large, thick-shelled and flat; those from southern waters about Hiroshima ("Kumamoto oyster") are smaller, broader, and deeper.

The margins of the valves of this species are smooth, completely lacking denticles. The interior is glossy white, the muscle impression may be white or colored partly or wholly brownish-purple. This oyster grows rapidly, attaining a length of 126 mm. (5 inches) or more in two years. Adult specimens in west American waters are commonly 150 to 175 mm. long.

EXPLANATION OF PLATE 2

Figs. 1, 2. *Ostrea lurida* CARPENTER, x 1. Typical form. Shoalwater Bay, Washington. Figs. 3, 6. *Ostrea lurida* CARPENTER, x 0.9. Grading toward forma *expansa* CARPENTER. Whistle buoy near Ventura, California. Figs. 4, 5. *Ostrea conchaphila* CARPENTER, x 1. San Diego, California. Figs. 7, 8. *Ostrea lurida* CARPENTER, x 1. Grading toward *O. palmula* CARPENTER. Fish Harbor, San Pedro, California. Fig. 9. *Ostrea lurida* CARPENTER, x 1.1. Grading toward forma *laticaudata* CARPENTER (specimen attached to another valve). San Diego Bay, California. Fig. 10. *Ostrea virginica* GMELIN, x 0.9. San Mateo Point, San Francisco Bay, California. Fig. 11. *Ostrea lurida* CARPENTER, x 0.9. Grading toward forma *rufoides* CARPENTER. San Quintín Bay, Lower California, Mexico. Figs. 12, 13. *Ostrea gigas* THUNBERG forma *laperousii* SCHRENCK, x 0.9. Humboldt Bay, California.

All specimens illustrated on this plate are in the type collection of the Department of Geology of the California Academy of Sciences.



Pilsbry called attention to a very large shell 449 mm. (17 5/8 inches) long.

Ostrea gigas offers serious competition to the native O. lurida where the two live in the same area. Galtsoff mentioned that O. gigas, a dioecious (sexes separate) species, not only filters more water than O. lurida but estimated that one female may extrude nearly 100,000,000 eggs into the water at the time of spawning, although many of these do not find conditions suitable for their growth. The adult O. lurida, on the other hand, may extrude perhaps 250,000 to 1,000,000 larvae but these have an advantage in that they already possess a shell when discharged into the water.

Among the enemies of the Japanese oyster are two introduced gastropods, Urosalpinx cinereus (Say), introduced with Ostrea virginica from Atlantic waters, and Ocenebra japonica (Dunker) from Japan.

Ostrea virginica Gmelin

Plate 2, Figure 10

This species, the "Virginia oyster" or "Eastern oyster", the type species of Crassostrea Sacco, was introduced into San Francisco Bay in 1870 where it was cultivated until about 1928 and where empty shells still are occasionally found. It also was introduced into other bays in California as well as in Washington and British Columbia. Successful reproduction did not take place in western waters and it was necessary to bring in seed oysters from the east coast where this species grows in countless numbers. Bryan mentioned that this oyster was introduced into Hawaiian waters in 1871 but it did not thrive there and it gradually disappeared.

The shell of this species attains a length of about 150 mm. and usually requires four or five years before it can be marketed. The margins of the valves are smooth and completely lack

denticles. The interior is white except the muscle impression which is blackish-purple.

Biologists have reported that one individual may discharge 14 to 15 million eggs into the water in one season and that this species, at least in some cases, interbreeds with Ostrea gigas.

An interesting feature of Ostrea virginica mentioned by Dall, is that many of the shells transplanted into San Francisco Bay acquired some of the characteristics of the shell of the native O. lurida, such as radiating folds or interlocking grooves and ridges.

At the present time, shipments of this oyster are brought to Drake's Estero and Tomales Bay where they are kept until they are marketed (H.G. Orcutt, oral communication).

References

- Bonnot, P.
1935. The California oyster industry. California Fish and Game. Vol. 21, No. 1, pp. 65-80, figs. 23-28, January.
- Chan, A. R.
1950. Oyster Culture in Japan. General Headquarters Supreme Commander for the Allied Powers: Nat. Res. Sec. (Tokyo), Rept. No. 134, pp. 1-80, figs. 1-40, September.
- Chapman, W. McL., and Esveltdt, G. D.
1943. The spawning and setting of the Pacific oyster (Ostrea gigas Thunberg) in the State of Washington in 1942. State of Washington Dept. of Fisheries, Biol. Rept., No. 43A, pp. 1-35, tables 1-13, figs. 1-7, July.
- Fitch, J.E.
1953. Common Marine Bivalves of California. State of

- California Dept. Fish and Game, Mar. Fisheries Branch, Fish Bull., No. 90, pp.1-102, figs. 1-63, 1 pl.(col.), 1953.
- Greengo, R. E.
1951. Molluscan species in California shell middens. Rept. Univ. Calif. Archaeol. Surv., No. 13, pp. 1-29, 1 fig., December 10.
- Kincaid, T.
1951. The oyster industry of Willapa Bay, Washington. (The Calliostoma Press: Seattle), pp. 1-45, 70 illustr.
- Palmer, K.V.W.
1958. Type specimens of marine mollusca described by P. Carpenter from the west coast (San Diego to British Columbia). Geol. Soc. America, Mem. 76, pp. 1-VI, 1-376, frontispiece, and pls. 1-35, tables 1-2, December 8.
- Townsend, C. H.
1893. Report on observations respecting the oyster resources and oyster fishery of the Pacific coast of the United States. U.S. Fish Comm. Fish and Fisheries, Pt. 17, Rept. of the commissioner for 1889-1891. (House Miscell. Doc. 113), pp. 343-372, pls. 2-12, issued 1893.

OVIPOSITION, HATCHING AND EARLY GROWTH OF *ARIOLIMAX COLUMBIANUS* (GOULD).

by

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(with Plate 3, figure 1)

In the course of an investigation of the reproductive cycle of *Ariolimax columbianus* (Gould) (Westfall 1952) a number of specimens were maintained in terraria, and from these animals a total of 10 clutches of eggs were obtained. No literature seems to have been published about oviposition in captivity or time of hatching for this species. This slug, one of the giant West Coast land slugs, is common in the Bay Area as well as along the North Pacific Coast.

Specimens of *Ariolimax columbianus* were collected from Leona Heights Park and from the campus of Mills College in Oakland, California. Slugs kept in terraria (plate 3, fig. 1) laid eggs during the period from November 5, 1951 to April 4, 1952. The terraria were kept in an unheated room throughout the year, and the animals were maintained on

a diet of lettuce leaves. Thirty-four slugs collected at the beginning of October in Leona Heights Park oviposited a total of 5 clutches of eggs between November and April. The number of eggs ranged from 10 to 35 per clutch. During this same period the Mills College campus slugs laid 4 clutches of eggs ranging from 2 to 32 eggs per clutch. The average number of eggs per clutch is similar to that obtained by Mead (1942) for the genus *Ariolimax*, which was 15 with a range of 7 to 26 eggs. The small number of 2 eggs observed by me may be due to partial oviposition in that spot, and the large numbers of 32 and 35 eggs possibly may be the result of two adults ovipositing in the same place.

Only once was a specimen observed in the act of oviposition. On March

31, 1952 this slug was found with 2 eggs already laid, and when it was picked up another egg emerged from the anterior edge of the mantle. The animal was swollen posteriorly, but the mantle appeared loose and folded. Dissection of the specimen showed a greatly distended oviduct containing 16 eggs.

A clutch of eggs may be laid overnight. They are deposited one at a time. (Mead (1942) obtained an average of forty-three minutes as the interval between eggs during the laying period.) The egg when laid is slightly oval with a thin white calcareous shell and is translucent. A typical egg of Ariolimax columbianus measures approximately 8 by 5 mm. Inside the shell is a membranous sac containing a colorless fluid. The embryo grows until it almost completely fills this sac. In one case a hatching slug was observed with the buccal cavity everted and extending through a portion of the egg case. Apparently the young slug rasps a hole in the egg case at the time of hatching and then crawls out. On one occasion an egg was picked up and the young slug emerged from one end of the egg case. It then rapidly crawled out of the rest of the egg case which collapsed upon the loss of liquid. Other terrestrial pulmonates are reported to rasp their way out of the egg case, and Binney (1851) observed Helix sayi feeding upon the cases immediately after emergence. Ariolimax may eat its egg cases too, which would explain why very few egg cases have been observed in the terraria in which A. columbianus have hatched. The few egg cases which were found after hatching were rather dirty sac-like membranes with a hole in one end.

The incubation period is at least three weeks and may be as long as two months or more, probably depending upon the environmental conditions. Out of 3 clutches of eggs laid on November 5 the first slug hatched in 23 days and the last one after two months. (Mead (l.c.) obtained an average of 46 days for the incubation period of this genus.) The

slug which hatched in 23 days was 17 mm. in length. It was light in color and rather translucent with a dark spot on the mantle over the shell. All the newly hatched slugs were spotted. Occasionally a maculated adult Ariolimax columbianus is found, but in general the spots disappear as the slug grows. The more mature slugs are a characteristic olive green in color. (Mead (l.c.) measured newly hatched Ariolimax at 14 to 21 mm. in length.) Measurements on individual young A. columbianus made in this study showed an extended length and approximate weight for age as follows:

1 day:	20 mm.;	0.15 gms.
1 week:	25 mm.;	0.3 gms.
2 weeks:	35 mm.;	0.6 gms.
4 weeks:	45 mm.;	0.7 gms.

Other weights taken at later ages were:

7 weeks:	0.7 gms.
8 weeks:	0.9 gms.
15 weeks:	3.5 gms.
17 weeks:	3.2, 3.4, 4.2, 4.5 gms.
18 weeks:	5.0, 6.3, 4.0 gms.
19 weeks:	3.0 gms.

In order to ascertain if this slug demonstrated preferences for various possible egg-laying habitats a simple experiment was performed. In the terraria shallow "caves" were made in a ridge of soil along one side. Out of 10 ovipositions 2 were made on the ridge above the "caves", 3 were made in the "caves", and 5 were made in the central flat area of the terrarium. Field findings indicate that a moist protected cavity is preferred. Paull (1951) stated that on January 18, 1950 twenty-seven eggs were found by Dr. Cadet Hand in a moist pocket behind a cut date palm frond two feet from the ground. On January 10, 1951 Paull found 6 eggs in a cavity under the trunk of a fallen buckeye tree, and on February 10 she found the remains of 2 clutches of eggs under a redwood log. All of these observations were made on the Mills College campus.

In summary it may be said that Ariolimax columbianus is most likely to be found laying eggs from late fall to early spring in clutches of around 15 eggs. The developmental period of the embryo may range from 23 days to over 2 months before hatching.

I would like to thank Mrs. Emily Reed for the illustration and Dr. Cadet Hand for reading the manuscript.

References:

Binney, A., 1851. The Terrestrial Air-Breathing Mollusks of the United States and the Adjacent Territories of North America, Vol. 11, p. 182. Boston: Charles C. Little and James Brown.

Mead, A. R. 1942. The Taxonomy, Biology, and Genital Physiology of the Giant West Coast Land Slugs of the Genus Ariolimax Morch (Gastropoda: Pulmonata). Cornell University Abstracts of Theses pp. 312-314.

Paull, C. J., 1951. The Anatomy of Ariolimax columbianus. Unpublished M.A. thesis, Mills College, 64 pages.

Westfall, J.A., 1952. The Reproductive Cycle of Ariolimax columbianus. Unpublished M. A. thesis, Mills College, 73 pages.

AN INTRODUCTION TO THE CLASSIFICATION OF OPISTHOBRANCH MOLLUSKS

by

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(with Figure 2, Plate 3)

Among the gastropods, the opisthobranchs are a group perhaps best known for their delicate form and beauty but are least understood from a systematic viewpoint. The purpose of this paper is to present a brief introduction to the higher taxonomic categories of opisthobranch mollusks and to suggest some methods of identification of genera and species in California.

Most opisthobranchs exhibit typical gastropod features in having a distinct head bearing tentacles and eyes, a broad flattened foot and a dorsal visceral hump. The soft fleshy covering over the visceral lump, known as the mantle, is in some of the orders

still produced into a free flap which encloses the mantle cavity. In this cavity, when it is retained, is located a single ctenidium, a characteristic structure of the mollusks. The word ctenidium is a specific term applied to the gills of mollusks. Basically, a ctenidium is an organ composed of a central axis along either side of which are borne numerous lamellae. Primitively, the ctenidia of gastropods are paired, but in higher prosobranchs and in some opisthobranchs, only a single ctenidium is retained. In many opisthobranchs, however, the mantle cavity and the true ctenidium are lost and other structures have been substituted for use in respiration. In addition, the

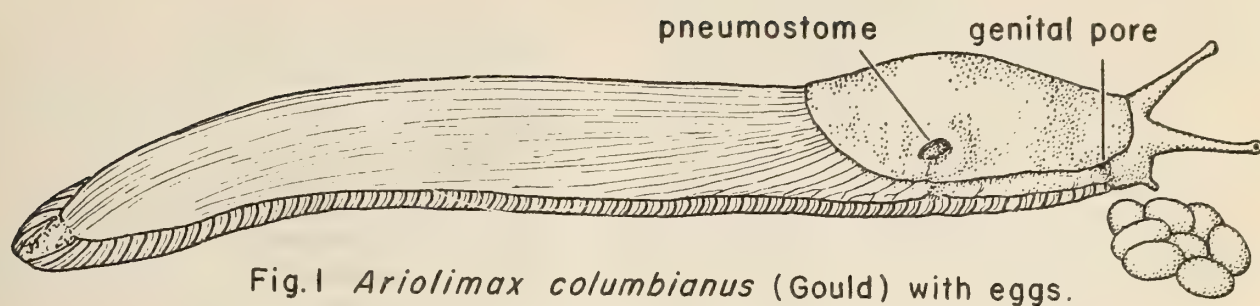


Fig. 1 *Ariolimax columbianus* (Gould) with eggs.

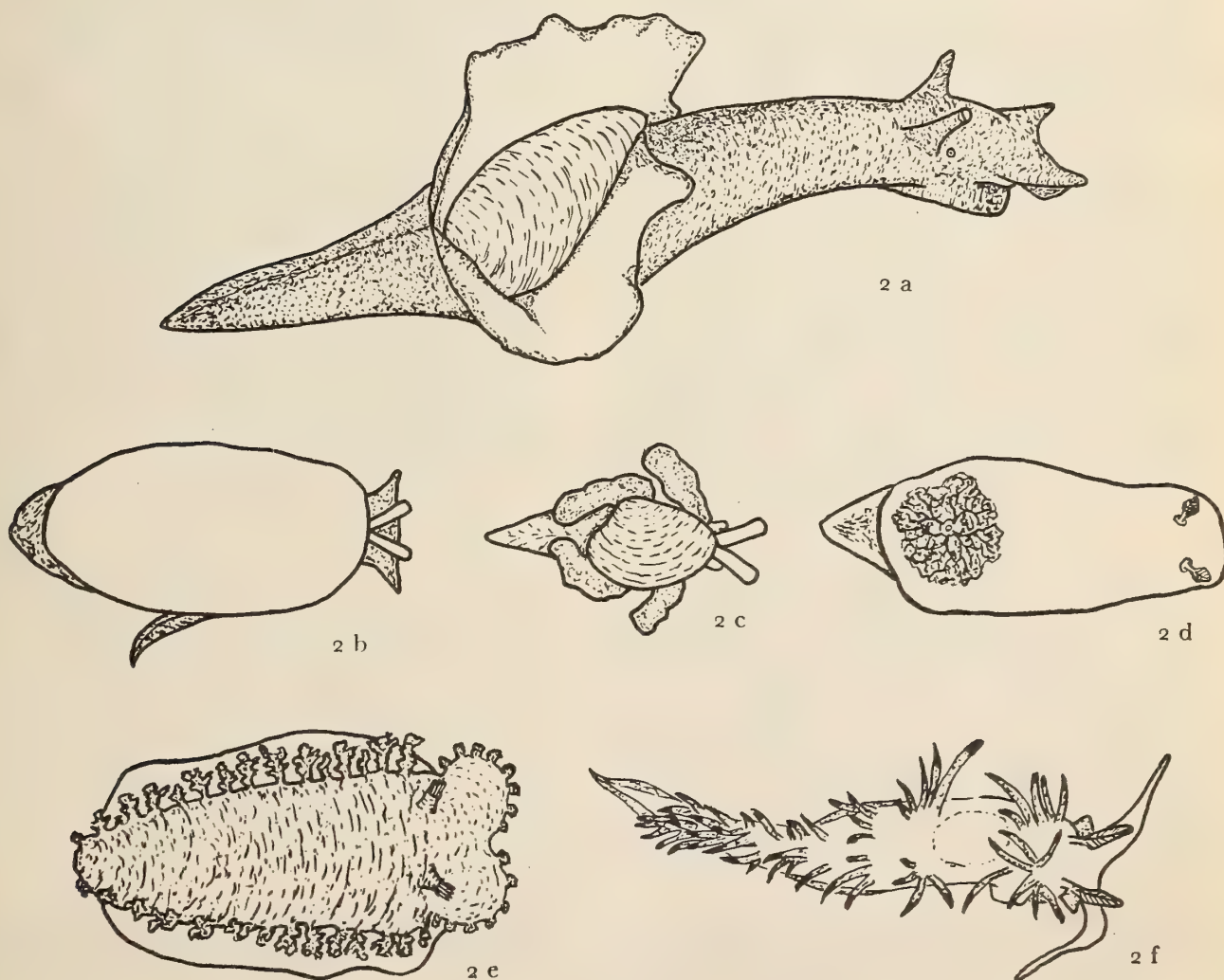


Fig. 2. Various Types of Opisthobranchs

single shell which is secreted by the mantle is much reduced in many species or may be present only in the embryo.

One of the major characteristics of the gastropods is the phenomenon of torsion, that process undergone by the embryo in which the visceral hump is rotated 180° in a counter-clockwise direction, thus bringing the mantle cavity and the ctenidia to lie just behind the head. Although the opisthobranchs exhibit this phenomenon in their embryonic development, there is a reversal of the process, called detorsion, which tends to return the mantle cavity and the ctenidium to a more posterior position. The amount of detorsion which takes place is correlated with the degree of reduction of the shell.

The terms Tectibranchia and Nudibranchia have long been commonly used as names for two major subdivisions of the sub-class Opisthobranchia. However, such a subdivision, while superficially useful, tends to give a false impression of the systematic position of the nudibranchs in relation to the other groups within the sub-class which are held to be of comparable systematic importance. The opisthobranchs may be divided more reasonably into seven orders, as follows:

Phylum Mollusca

Class Gastropoda

Sub-class Opisthobranchia

- Order Cephalaspidea
- Order Pteropoda
- Order Acochliidae
- Order Anaspidea
- Order Sacoglossa
- Order Notaspidea
- Order Nudibranchia

Other classifications of the group have been proposed but I find this one to be highly satisfactory.

The common bubble shell, Bulla gouldiana Pilsbry, and the black and

white striped Actaeon punctocaelata Carpenter, are two well known examples of the order Cephalaspidea in California. Of all the opisthobranchs, many cephalaspideans resemble most nearly the prosobranch gastropods in general form. They may be distinguished from the prosobranchs, however, by the presence of the single true ctenidium in the mantle cavity which is located in a somewhat posterior position on the right side. Cephalaspideans almost invariably possess a shell and in many it is external and large. Those with large shells are usually capable of withdrawing themselves completely into it and some, such as Actaeon, still retain an operculum.

The cephalaspideans, as the name implies, are characterized by possessing a head shield, that is, a fleshy covering, which may assume various forms, lying over the head and the anterior part of the body. Rhinophores, the sensory tentacles borne dorsally on the head of an opisthobranch, posterior to the cephalic tentacles, and which, by some workers, are presumed to function as chemoreceptors, are absent in the cephalaspideans. Some of the families in the order are distinct enough in their general body form to be recognized easily but positive identification is made only by the examination of the radula and internal anatomy.

The pteropods are a group of pelagic opisthobranchs, representatives of which are seen occasionally in offshore plankton samples from California waters. The shell and mantle cavity may be present or absent but the presence of lobes developed from the dorsal surface of the foot (epipodial lobes), with which the animal swims, is a characteristic feature of the group.

Members of the order Acochliidae are small sand dwelling opisthobranchs which are rather worm-like in appearance but often bear rhinophores and other anterior tentacles. To my knowledge, none has ever been collected in

California.

The sea hares (Fig. 2a), which comprise the order Anaspidea, are represented in California by Aplysia (= Tethys) californica Cooper and by a green and black striped form living on Zostera on mud flats: Phyllaplysia taylori Dall. As the name of the order suggests, the sea hares lack a shield of any kind. The edges of the foot are produced into lobes which are recurved over the back of the animal. In some representatives of this group, such as Aplysia, these lobes may be used in swimming, but in Phyllaplysia the lobes are somewhat united posteriorly and the animal is restricted to crawling. The mantle cavity and ctenidium are located dorsally and the shell is largely or completely enclosed by the mantle.

One conspicuous feature of the anaspideans is a furrow running dorsally to laterally on the right side from the female genital opening and vas deferens which open near the ctenidium to the penis which is located near the right cephalic tentacle. Anaspideans possess two pairs of head appendages which are characteristically slit or folded. The anterior pair, called cephalic tentacles, are lateral extensions of the head. The more posterior pair are true rhinophores.

General body form and coloration, as well as the characteristics of the shell and radula, are used for distinguishing the families, genera and species of this order. The treatment of this group and of the cephalaspideans and notaspideans in Tryon and Pilsbry, 1896, is an excellent introduction to the systematics of these orders. However, these authors have included the family Oxynoeidae in the order Anaspidea, whereas it is now considered to be a family within the next order to be discussed: the order Sacoglossa.

The families composing the order Sacoglossa are very diverse in external form and an examination of the radula and internal anatomy is necessary for

positive identification. The mantle cavity and ctenidium are absent in most families in this group but are present in the family Oxynoeidae, whose members also possess shells. Lobiger, an oxynoeid genus not found in California is pictured in fig. 2c. Other members of the order lack shells and some resemble, superficially, eolid nudibranchs and even turbellarian flat-worms. In California, two sacoglossans which are not uncommon and which resemble eolids are Phyllobranchopsis enteromorphae Cockerell and Elliot which occurs on Enteromorpha in high rocky tide pools and Alderia modesta (Alder and Hancock) which lives in Salicornia marshes. Phyllobranchopsis may be distinguished from an eolid by the presence of folded rhinophores, a feature common to most sacoglossans which possess rhinophores. Alderia lacks rhinophores but is distinguishable by another not uncommon sacoglossan characteristic, that is, the eyes, visible through the integument, are located in a region of very light pigmentation, giving the anterior end of the animal a somewhat planarian appearance. As has been noted above, sacoglossans which do not possess any body appendages resemble flatworms more than opisthobranchs.

The notaspideans possess a broad back shield covering most of the animal. A true mantle cavity is absent but a ctenidium is borne on the right side under the back shield. The ctenidium of Pleurobranchaea, a shell-less notaspidean, may be seen protruding from the right side of the animal in fig. 2b. Some notaspideans possess shells. Tylodina fungina Gabb, in California, bears an external, conical, limpet-like shell but the shells of relatives of Pleurobranchaea are reduced and are often internal.

The cephalic tentacles which take the form of a truncated pyramid and the folded rhinophores as shown in the figure of Pleurobranchaea, are

characteristic of the order and serve as an easy means of distinguishing these animals from the dorid nudibranchs which they resemble superficially.

The order Nudibranchia is by far the most complex and diversified of all the opisthobranch orders. Mantle cavity, ctenidium and shell are all absent in the adults. Secondary breathing appendages, called branchiae have been developed by many members of the group and, in cases where branchiae are absent, the body surface area has been expanded and respiration takes place through the integument. Fig. 2d shows a typical dorid nudibranch which possesses a circlet of branchiae dorsally and posteriorly. In *Duvaulcelia* (fig. 2e), a dendronotacean, the branchiae are arranged in two rows along the dorso-lateral margins of the back. The eolids (fig. 2f) lack branchiae but the presence of cerata, dorsal appendages of the body into which branches of the digestive diverticulum may extend, increases the body surface area. The variations in nudibranch body form are so numerous that it would be impossible to describe them here. For an introduction to the group I recommend Hoffman's volume on the Bronn's Klassen und Ordnungen des Tierreichs. Although the work is in

German, the illustrations of both general body form and individual parts of both nudibranchs and other opisthobranchs will often permit identification to family and sometimes to genus. For descriptions of the various species of nudibranchs in California the reader is referred to the bibliography for the opisthobranchs in Intertidal Invertebrates of the Central California Coast by Light et al. The papers contained therein give descriptions of or references to most of the species which will be encountered.

Literature cited

- Hoffman, H., 1939, in Bronn, H. G. Klassen und Ordnungen des Tierreichs, Leipzig. Bd. 3, Abt. 11, Buch 3: Opisthobranchia. 1247 pp. 830 fig.
- Light et al., 1954. Intertidal Invertebrates of the Central California Coast. Univ. Calif. Press, Berkeley. 446 pp. 138 fig.
- Tryon G. and H. Pilsbry, 1896. Manual of Conchology, vols. XV and XVI. Acad. Nat. Sci., Phila.

BIOLOGICAL COLLECTING IN ANTARCTIC WATERS

by
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(These studies were aided by a contract between the Office of Naval Research and the University of California. The facilities and ships of the Argentine Navy were used during the course of the investigations.)

During the austral summer of 1957-8 the writer was privileged to take part in the Argentine Antarctic Expedition. The areas visited included the South Shetland Islands and points along the Palmer Peninsula bordering the Bellingshausen

sea. As in the Arctic, intertidal collecting in the Antarctic is generally impossible due to the abrasive action of floating ice in the inter-

tidal areas. Further difficulties are encountered in areas where glaciers extend out directly into the water, leaving no intertidal zone exposed. Skottsberg (1941) reports luxuriant growth of plants in the intertidal only in protected localities. One area with an intertidal growth was found by the writer in the South Shetland Islands; such places are, however, quite rare.

The use of the dredge by Gain (1912) and Skottsberg (1906) provided the first indication of the abundance of marine plants and animals bordering this continent. The nature of the bottom in many areas was such that the dredge merely skipped over the surface of the rocks or became caught between them. Skottsberg (1941) states that the only reliable way of obtaining an accurate idea of the plants and animals growing in Antarctic waters is through the use of a bathysphere or by diving.

The successful use of self contained underwater breathing apparatus, or SCUBA as it is called by Bascom and Revelle (1953), and the exposure suit in temperate waters has led to their acceptance as an important new tool for marine biological studies. It was not known, however, if a scientific program involving daily working dives was practicable with this type of equipment in the extremely cold Antarctic waters. Thus a number of different types of exposure suits, fins, face plates, hoods, boots, mittens and other diving paraphernalia were assembled prior to the expedition. Combinations and modifications of the diving gear were tried during initial tests in Tierra del Fuego, and at the Argentine naval base, Teniente Camara, in the South Shetland Islands.

The most advantageous suit from the point of mobility, warmth, and ease of working was a slightly modified wet-type foam-neoprene suit. These suits were tailored to fit the diver. Nothing was worn under or over the suits, the only insulation being the minute bubbles of air entrapped in the foam-neoprene. A

small amount of water seeps into the suit initially, however it is quickly warmed by the body as it does not circulate. Mittens and boots of the same material were used, being made with long cuffs so that there was a good seal preventing circulation of water in the suit. The hood covered the entire face except the nose and eyes which were covered by the face mask, the snorkle or regulator mouthpiece fitting tightly through a small hole to the mouth. Thus the diver when fully dressed had no portion of his body exposed to the water at any time. Even the slightest exposure proved very uncomfortable, if not painful.

The greatest difficulty was experienced in keeping the hands and feet warm. With both dry- and wet-type suits any tightness of the boot or mitten restricts blood circulation and the hands and feet soon become numb and cold. This problem was avoided by using large fins and roomy boots and mittens. Suits were checked for leaks prior to each dive and special care was taken to check to see that all sections of the suit overlapped assuring that there were no exposed parts of the body and no chances for circulation of water.

Using the foam-neoprene suit a major portion of the collecting was done by diving from the surface with a snorkle. Plants and animals were collected to depths of 30 feet in this way. A combination of snorkle and neoprene exposure suit opened up rich collecting areas, making it possible to obtain large collections in a very short time. Mollusks such as Nacella polaris were ubiquitous and easily collected. Chitons were also found on the sides and beneath rocks. Fish (mostly Notothenia accoriceps) were few, but were easily collected since they moved only when touched or otherwise disturbed.

Collecting animals and plants under water presented no special problems.

The mittens used made it somewhat difficult to pick up small shells or plants; however, with the aid of a short knife and a small cloth collecting bag they could be collected.

No collections were made under solid ice, but on several occasions dives were made in brash or loose growler ice. At such times it is necessary to exercise great care since suits can be cut on the sharp edges of freshly broken ice. Larger pieces moving in the water can severely bruise a foot or hand, particularly when one is entering or leaving the water near the shore. Nevertheless, loose ice presents no insurmountable problem to collecting in shallow water. In deeper water surface ice limits visibility and hampers collecting. In such cases rocks were brought to the surface and examined for smaller plants and animals.

During a total of 71 days in the Antarctic 33 dives were made in water ranging in temperature from $+1^{\circ}\text{C}$ (34°F) to as low as -1.5°C (29.5°F). The longest continuous period spent in the water was over one hour.

Due to the almost complete lack of habitats, collecting in Antarctic waters is effectively limited to either dredging or diving. In the latter case the collecting tool is essentially the scientist himself, human senses being substituted for the blind groping of the dredge. SCUBA diving is a highly versatile tool that can be used effectively even in polar areas.

Literature Cited

1. Bascom, W.N. and R. Revelle 1953. Free diving: a new exploratory tool. *Amer. Sci.* 41(4):624-627
2. Gain, L. 1912. *La flore algologique des regions antarctiques et subantarctiques*. Paris 1912
3. Skottsberg, C. 1906. Observations on the vegetation of the Antarctic sea. *Bot. Stud.* till F.R.Kjellman, Uppsala 245-64.
4. Skottsberg, C. 1941. Communities of marine algae in subantarctic and antarctic waters. *K. Svenska Vetenskapsakad. Handl.* Vol 19: 1-9

WHY RULES OF PRIORITY?

by

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In our previous installments we have discussed the confusions in molluscan nomenclature and how they had arisen; also it was explained what efforts have been made to clear up some of these confusions and we mentioned the rules applicable to names given to various species in the past.

It is quite obvious that rules to be practical, must be of such a nature that they will not tend to add to the

confusion already existing but will rather remove it. Therefore, rules affecting situations that arose in the past make certain concessions which rules, affecting the present and future naming of new species, do not have to make. For example, it would make no sense to specify that the type locality of a species must always be indicated in degrees longitude and latitude and that, lacking that information, the name is invalid. In the past many

species have been described which came from places that either were known only by some local name, not found on any map, or that had not been accurately noted down by the collector. Also, quite often new species were described from shells that were purchased from a "sailor" or some other similarly reliable source, so that the origin of the specimen was completely unknown. And to top all of these uncertainties off, it has happened in more than one case that on a prolonged expedition the bottles or other containers got mixed up and we then have situations such as the following: described from "Upper California" in 1837 was Purpura dumosa Conrad, which is a species found on the Hawaiian Islands (present name is Morula porphyrostoma (Reeve)). In the same paper there were also described as from Upper California several species of shells picked up in the Azores!

What we have shown to hold for this rule is equally true for several others; it is impractical to make all rules retroactive. After December 31, 1930, all descriptions of new species or lesser units must comply with these rules:

A name proposed for a new species must be accompanied by a description or a definition which distinguishes this species from other species (the same rule applies for genera).

It may be followed with a definite bibliographic reference to such a description of characters instead of having the description itself repeated.

For a new genus it is essential that a type species be designated in a very clear and definite manner so that there can be no question as to what is meant.

The author must apply the principles of binary nomenclature.

In addition to these hard and fast rules, there are several points which are very desirable and should, if at all possible, be observed:

Compare not only the shell but the entire living animal of the new species with its nearest relative among the previously known species.

Pick one particular specimen to describe as carefully as possible, designate it as the holotype, and illustrate it as completely and as carefully as possible. Use several other specimens collected in the same locality and, if feasible, at the same time as the holotype specimen to describe variability within the species; these latter specimens then become paratypes.

Give as much information as possible about the type locality and indicate it not only with a name from a good map but also as closely as possible with geographical longitudes and latitudes. The type substrate (or the ecological niche) of the type specimen should be described, if at all possible.

While it is permissible to describe a new species based on a single specimen, it is better to endeavor to obtain several specimens before deciding to name a new species.

If a subspecies is described, then the name of the species is to be followed by the subspecies name; the original or typical species has then its species name doubled. In other words, our Amphissa versicolor Dall, 1871, had several supposed subspecies. In 1919 Dall described and named one of these incisa. If we were to recognize the "subspecies" incisa then the name would be Amphissa versicolor incisa Dall, 1919, and the "typical" species would be named Amphissa versicolor versicolor Dall, 1871. This is not too bad, but remember the case of the common toad of Europe? There the genus name is Bufo; since an asiatic variety, a true subspecies has been named Bufo bufo asiaticus, the original species now must be called Bufo bufo bufo (Linnaeus, 1758). And that, you will agree, sounds ridiculous - but it is not.

Brief notes on interesting Ascidiens
by

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While on a field trip in search of molluscs in the Gulf of California in February, 1959, Dr. R. Stohler of the Department of Zoology, University of California, Berkeley, collected four species of ascidians from the sand flats about 30 miles south of San Felipe, Baja California (ca. 30° 30' N; 114° 42' W). Two of these species are worthy of special note.

Eudistoma mexicanum is a little-known species which was described by Van Name (1945) from some poorly preserved specimens in the United States National Museum taken from the extreme north end of the Gulf of California. The general form of the colony is unique in that it is extremely elongate. The specimens collected by Dr. Stohler varied in length from six inches to six feet and were from one half to one inch in diameter. A second unusual feature is that the colony is unattached and rolls free in the water over the surface of the sand in tangled masses. Because of the condition of the material with which he was working, Van Name could give little description of the zooids, but the colony form is so unusual that there is little doubt that this is E. mexicanum.

The second species, Molgula manhattensis, is common on the east coast of the United States and has more recently been found in San Francisco Bay and is now known to occur in the northern part of the Gulf of California. As is usual in this genus, the individuals are found embedded in the sand with the siphons protruding. The specimens collected by Dr. Stohler are remarkable for their large size. Previously, Van Name had reported that the largest specimen he had seen was 35 mm. by 35 mm. However, in the Gulf of California 50 mm. by 40 mm. is a common size.

The other two species collected were on hard substrates protruding through the sand and were Amaroucium californicum and Didemnum sp.

Bibliography:

Van Name, W. G., 1945. The North and South American Ascidiens.
Bull. American Mus. Nat.
Hist. 84:1-476

Brachidontes or Hormomya?

by

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On April 26, 1959, while collecting among some rocky outcroppings in a small cove just north of Laguna Beach, Orange County, California, a single living specimen of a peculiar mytilid bivalve was found.

According to Dr. Myra Keen (personal communication), the shells belong to a variable group which make it unwise to attempt to identify them on the basis of a single specimen as either of two likely species, Brachidontes puntarenensis (Pilsbry and Lowe, 1932) or Hormomya adamsiana (Dunker, 1857)

Both of these species are very variable. In general appearance the shells from Laguna Beach are very similar to the photograph of B. puntarenensis on page 49 of Keen "Sea Shells of Tropical West America", Stanford University Press, 1958.

Brachidontes puntarenensis has been reported only from Costa Rica. The northern limit of Hormomya adamsiana, while not definitively established, extends into California at least as far north as Laguna Beach.

The significance of this specimen can be determined only by observing

the variability in a series of specimens collected in the general region of Laguna Beach.

The shells have been deposited in the study collection of the University of California, Department of Zoology.

Mitra montereyi Berry from the
Monterey Peninsula
by

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Two occurrences of Mitra (Atrimitra) montereyi Berry off the Monterey Peninsula, California, were recently noted.

Lester Kent, an employee of the University of California Museum of Paleontology about a year ago brought me for identification several shells which he had collected while skin diving off Monastery Beach at depths ranging between 75 and 100 feet, the latter being the lower limit of his dives. According to his report these shells, which proved to be Mitra montereyi, occur abundantly at such depths among the relatively bare granitic rocks.

I encountered Mitra montereyi on May 16, 1959, while exploring the shallow shelf off the north side of Lovers Point, Pacific Grove, at a depth of about 30 to 35 feet. The bottom there consists of outcrops of granitic rock, possibly similar to the Monastery Beach locality, with intervening patches of medium to coarse sand. The variously colored bat star, Patiria miniata (Brandt), and the great purple sea urchin, Strongylocentrotus*(Agassiz), occur abundantly on the rock outcrops, while near the surface of the sand-patches Olivella biplicata (Sowerby) could be observed.

*franciscanus

Mitra montereyi heretofore has been dredged between 5 and 100 fathoms and was obtained in a number of localities between Monterey and Redondo Beach.

BOOKS AND PAMPHLETS

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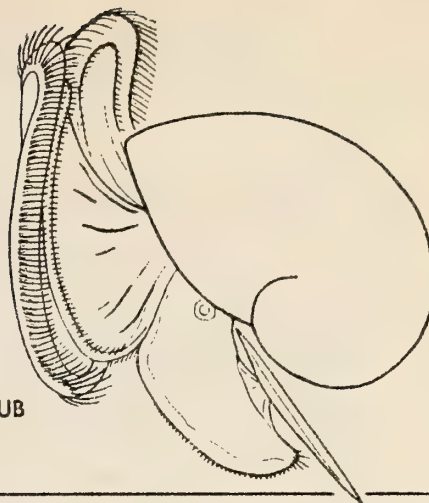
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THE PELECYPOD DOSINIA IN THE LOWER OLIGOCENE OF CALIFORNIA

by

Dr. J. Wyatt Durham

Museum of Paleontology, University of California, Berkeley 4, California
(Plate 4)

The earliest occurrence of the pelecypod genus Dosinia has been used by Stewart (1930), and by Hirayama (1956), as well as by others, as an indicator of an age not older than Aquitanian (either latest Oligocene or earliest Miocene according to the chronologies used, but considered earliest Miocene) in Pacific Coast "megafaunal" terminology. Substantiation (Durham, 1957) of Clark's report (1918, pp. 88, 90) of Dosinia in the "lower Kirker formation" or Kirker sandstone (see Clark in Weaver, et al., 1944, p. 586, note 115, and correlation chart, column for "North Side of Mount Diablo") of lower Oligocene age in Central California, demonstrates the nonvalidity of this particular criterion. It is the purpose of this paper to discuss this occurrence as well as the pre-Aquitanean occurrences of Dosinia elsewhere.

A brief account (Durham, 1957) of the discovery of additional specimens of Dosinia in the lower Kirker formation or in Clark's revised terminology (see Weaver, et al., 1944, loc. cit.) the Kirker sandstone, has been presented elsewhere. The beds in which Dosinia occurs are exposed on the north side of Mount Diablo, about seven and a half miles north of the summit, and about a mile west of Kirker Creek. They are overlain by the Kirker tuff and underlain by the Markley formation. Their lateral extent is small, and according to Clark (1918, pp. 87, 89) they have a thickness of 50 feet. Fossils from the sandstone are preserved in the collections of the Museum of Paleontology of the University of California (Berkeley) under locality numbers 78 (Clark's collection) and A4660. Both numbers probably represent the same collecting locality.

The fossils from these two localities, in addition to the Dosinia, include Acila shumardi Dall (abundant), Bruclarkia columbiana (Anderson and Martin) [probably the species recorded from locality 78 by Clark, 1918, p. 91, as Agasoma gravidum Gabb], Pitar clarki (Dickerson), Yoldia tenuissima Clark, Molopophorus sp. (either M. gabbi Dall or M. dalli Anderson and Martin) [probably the species recorded as M. cf. biplicatus Gabb by Clark, loc. cit.], and Mytilus arnoldi Clark [type locality]. Additionally Clark (loc. cit.) recorded several other gastropods and pelecypods, some of which are misidentified, from locality 78.

The presence of Acila shumardi Dall indicates, as noted by Schenck and Kleinpell (1936, pp. 219, 221-222) that the containing strata fall within the Refugian stage of those authors. Schenck and Kleinpell likewise note (op. cit., p. 222) that Dosinia occurs in faunas of Refugian age and refer to Stewart's (1930, p. 230) citation of Clark's record of Dosinia mathewsonii from this locality. Acila shumardi, along with Bruclarkia columbiana (Anderson and Martin), Pitar clarki (Dickerson), and the Molopophorus indicate that these beds are to be correlated with the Molopophorus gabbi zone of Durham (1944, p. 112). No matter whether one accepts the "megafossil" [metazoan] or "microfaunal" [foraminiferan] chronologies, the Weaver, et al. (1944) chart shows this particular interval as correlated with the Tongrian stage of Europe. The Tongrian was cited as the lowermost part of the Oligocene in the original proposal of the term by Beyrich. Thus if the correlations with Europe are even approximately correct, Dosinia occurs in the

Oligocene, and probably in the lower part -- certainly it occurs in beds which on the basis of their fauna are of lower Oligocene age as that term has commonly been used on the Pacific Coast.

The specimens of Dosinia from locality A 4660 are all poorly preserved externally, but preparation of the interior (Pl. 4, figs. 1, 4, 5) shows clearly that they are very closely related to D. mathewsonii Gabb (Pl. 4, figs. 2, 3), the species to which Clark (*op. cit.*) assigned his material. Comparison with the Recent D. ponderosa (Gray) (Pl. 4, figs. 6, 7) and D. dunkeri (Philippi) (Pl. 4, figs. 8, 9) shows a close similarity in the hinge plate and internal features of the shell and substantiates the close relationship of D. mathewsonii to the living species as suggested by Stewart (1930, p. 231). The pallial sinus, on the single specimen from the Kirker sandstone (Pl. 4, fig. 4) in which this character can be seen, is higher and slightly more rounded than in D. mathewsonii (Pl. 4, fig. 2). Likewise the dorsal portion of the nymph plate is more strongly inclined from the vertical, in the two specimens (Pl. 4, figs 1, 4) in which this character can be observed, than in D. mathewsonii (Pl. 4, fig. 3). The differences noted in the nymph plate and pallial sinus seem adequate to indicate that the specimens from the lower Oligocene represent a new species, but because of the lack of a specimen with a well preserved exterior, it is not given a name at this time.

Both Dosinia mathewsonii and the species from the Kirker sandstone have a high ridge (Pl. 4, figs. 3, 5) external to the posterior part of the nymph plate and differ considerably from D. dunkeri (Pl. 4, fig. 9) in this character. However some (but not all) specimens of D. ponderosa (Pl. 4, fig. 7) have an even higher and thinner ridge in this position. Despite these differences, it seems that these four species of Dosinia as well as others in the Pacific Coast Tertiary are refer-

able to the subgenus Dosinidia Dall (1902, p. 347). Dall considered this group to be confined to the tropical and warm temperate seas of the Americas, but it should be noted that Slodkewitsch (1938, p. 165, pl. 88, figs. 3-4 [however not his fig. 5, which is copied from Wiedey, 1928, pl. 18, fig. 2]) has reported Dosinia margaritana Wiedey, originally described from the lower Miocene of California and referable to Dosinidia, from the Miocene of Kamchatka. Unfortunately his figures are inadequate for positive determination, but the apparent type of ornamentation suggests that the identification is incorrect. The northernmost verified record along the Pacific Coast is from the lower Miocene of Coos Bay, Oregon (James, 1950).

Olsson (1931, pp. 20, 59, pl. 7, fig. 1) described Dosinia (Dosinidia) palmerae from the late Oligocene (pre-Aquitania) Caloto-Moro shales of Peru, thus the subgenus Dosinidia is recorded from pre-Miocene (pre-Aquitania) rocks elsewhere in the New World.

The Japanese fossil species referred to the genus Dosinia (*s. l.*) have been referred to the subgenera Dosinella Dall (1902), Kaneharaiia Makiyama (1936) or Phacosoma Jukes-Brown (1912). Inasmuch as there are no undoubted records of the subgenus Dosinidia in the western Pacific, conclusions as to the age significance of the genus Dosinia (*s. l.*) that are based on the record in the Americas are not particularly significant.

Elsewhere in the Indo-Pacific region however, the genus Dosinia (*s. l.*) appears even earlier than in the Americas. In New Zealand where Marwick (1927, pp. 581-591) and others have recognized a number of subgenera (including the typical subgenus), the subgenus Kakahuia Marwick (1927) is recorded (Fleming, 1950, p. 246) from beds of Eocene age and the subgenus Dosinobia Finlay and Marwick (1937) was described from beds considered to be of late Cretaceous (Danian) age (Finlay and Marwick, 1937, pp. 34-35). However the Danian is

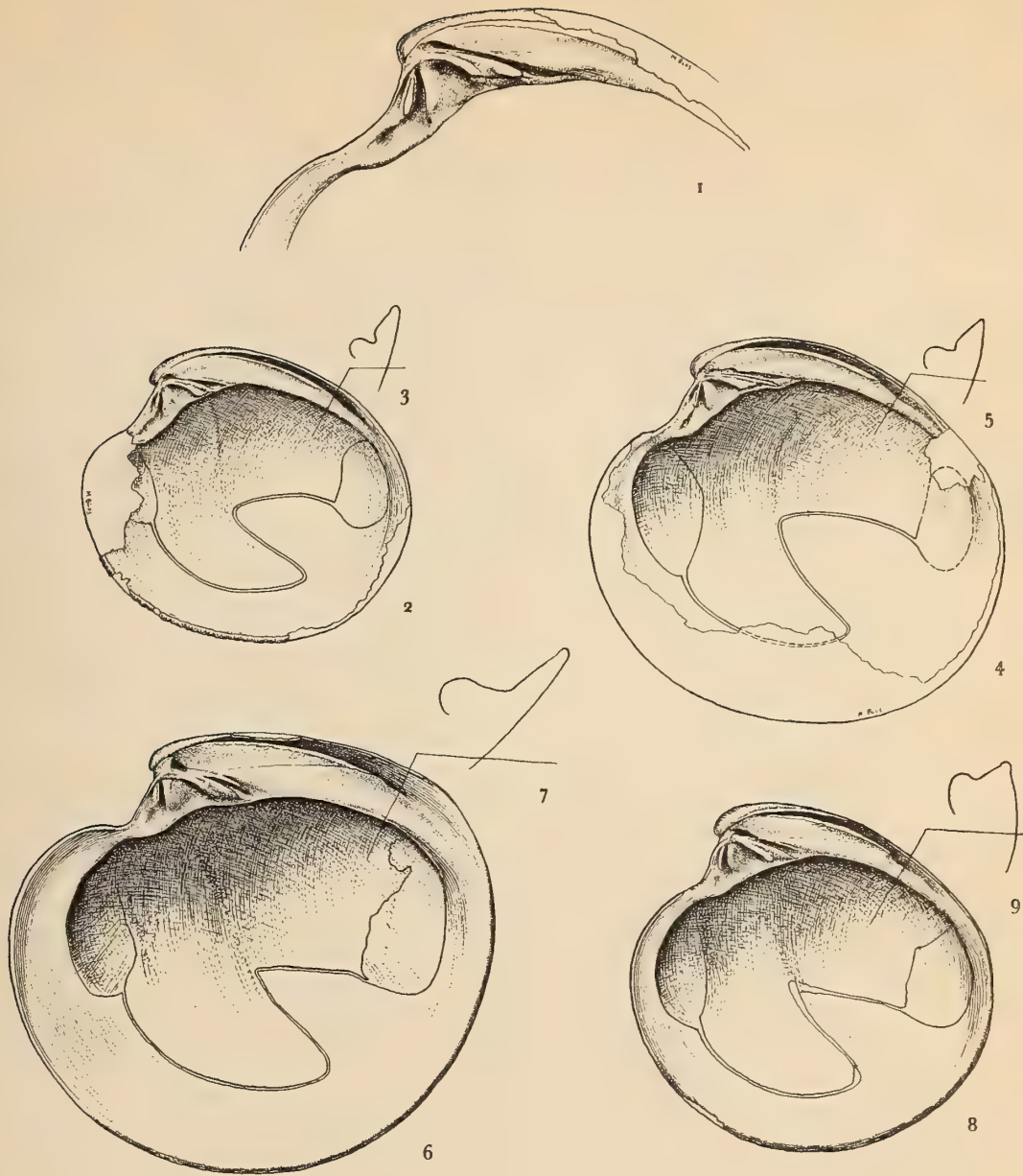


Fig. 1. *Dosinia (Dosinidia)* n. sp. (x 2). Univ. Calif. Mus. Paleo., hypotype no. 30013. Lower Oligocene, California.
 Fig. 2. *Dosinia (Dosinidia) mathewsonii* GABB. (x 1). Univ. Calif. Mus. Paleo., hypotype no. 11149 A. Lowermost Miocene, California. Extreme edge of dorsal margin slightly restored. Fig. 3. Same specimen as fig. 2, (x 2). Profile across hinge.
 Fig. 4. *Dosinia (Dosinidia)* n. sp. (x 1). Univ. Calif. Mus. Paleo., hypotype no. 30012. Lower Oligocene, California. Extreme edge of dorsal margin slightly restored. Fig. 5. Same specimen as fig. 4, (x 2). Profile across hinge plate.
 Fig. 6. *Dosinia (Dosinidia) ponderosa* (GRAY). (x 0.75). Univ. Calif. Mus. Paleo., hypotype no. 30014. Recent. Fig. 7. Same specimen as fig. 6, (x 1.5). Profile across hinge plate.
 Fig. 8. *Dosinia (Dosinidia) dunkeri* (PHILIPPI). (x 2). Univ. Calif. Mus. Paleo., hypotype no. 30015. Recent. Fig. 9. Same specimen as fig. 8, (x 2). Profile across hinge plate.

Profile across hinge plate.

now generally considered basal Tertiary (Paleocene) rather than latest Cretaceous by many authors. Presumably this record is the basis of the age range of Cretaceous to Recent given in the *Traité de Paléontologie* (Dechaseaux, 1952, p. 306) for the genus Dosinia (s. l.). Many, if not all of the older records from the Cretaceous that have been referred to Dosinia (s. l.) seem better assigned to the genus Dosiniopsis Conrad (1864) which Frizzel (1936, p. 64) places in the family Suncettidae.

In 1930 Stewart (1930, pp. 20, 229-230) suggested that the San Ramon formation of Central California was probably of Miocene age, rather than Oligocene as suggested by Clark (1918, pp. 110-111). His argument was primarily based on the occurrence of the genus Dosinia (s. l.) in the type San Ramon formation and he seemingly failed to appreciate the significance of Clark's report (ibid., pp. 88, 90) of Dosinia in the Kiker formation. At the same time Stewart (ibid., pp. 42-43) in an addendum to his paper, suggested that the occurrence of Dosinia in the fauna of the Ashiya "Group" of Japan indicated an age not older than Aquitanian (basal Miocene in Stewart's terminology) for the fauna of those beds. Recently Hirayama (1956, pp. 39-97) has repeated Stewart's arguments and used them along with others to indicate that the "Ashiya Fauna" is of Aquitanian age (uppermost Oligocene in Hirayama's terminology).

Both the San Ramon formation (see Weaver, et. al., 1944) and the "Ashiya Fauna" may well be of Aquitanian age (lower Miocene of current Pacific Coast "megafossil" terminology) but the occurrences cited earlier in this paper show that the first occurrence of the polycypod Dosinia (s. l.) is not a valid criterion for this age determination.

In summary, the subgenus Dosinidia occurs in beds of lower Oligocene age in California and the genus Dosinia (s. l.) is recorded from beds of Paleocene (sub-

genus Dosinobia) and Eocene (subgenus Kakahuia) ages in New Zealand and from beds of both early and late Oligocene (subgenus Dosinidia) in the Americas. Thus the usage of the presence of Dosinia (s. l.) as an indicator of Miocene (including the Aquitanian) or younger age is not significant.

LITERATURE CITED

- Allan, Joyce
1950. Australian Shells. Pp. 1-470, pls. 1-44 (Georgian House, Melbourne).
- Clark, B. L.
1918. The San Lorenzo Series of Middle California. Univ. Calif. Publ., Bull. Dept. Geol., vol. 11, pp. 45-234, pls. 3-24.
- Clench, W. J.
1942. The genera Dosinia, Macrocallista and Aniantis in the Western Atlantic. *Johnsonia*, vol. 1, no. 3, pp. 1-8.
- Dall, W. H.
1902. Synopsis of the Family Veneridae and of the North American Recent Species. Proc. U. S. Nat. Mus., vol. 26, pp. 335-412, pls. 12-16.
- Dechaseaux, Colette
1952. Classe des Lamellibranches, in Pivoteau, Jean, *Traité de Paléontologie*, vol. 2, pp. 220-246, 261-364.
- Durhan, J. W.
1944. Megafaunal Zones of the Oligocene of Northwestern Washington. Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 27, pp. 101-212, pls. 13-18.
- 1957. Polycypod Dosinia in lower Oligocene of Central California. Bull. Geol. Soc. Amer., vol. 68, pp. 1823-1824 (abstract).
- Finlay, H. J., and J. Harwick
1937. The Wangaloan and associated Molluscan Faunas of Kaitangata-Green Island Subdivision. New Zealand Geol. Surv. Branch, Paleont. Bull. 15, pp. 1-140, pls. 1-17.

- Fleming, C. A.
1950. The Molluscan Fauna of the Pahi Greensands, North Auckland. Trans. Roy. Soc. New Zealand, vol. 78, pp. 236-250, pl. 24.
- Frizzel, D. L.
1936. Preliminary reclassification of Veneracean Polycypods. Bull. Mus. royal. Hist. nat. Belgique, vol. 12, no. 34, pp. 1-83.
- Hirayama, Katsumi
1956. Tertiary Mollusca from Miko-shima, Yamaguchi Prefecture, Japan, with remarks on the geological age of the "Ashiya Fauna". Sci. Repts. Tokyo Kyoiku Daigaku, Sec. C, vol. 5, pp. 81-127, pls. 6-8.
- James, Ellen L.
1950. New Marine Fauna from Coos Bay, Oregon. Bull. Geol. Soc. Amer., vol. 61, p. 1539 (abstract).
- Marwick, J.
1926. The Veneridae of New Zealand. Trans. New Zealand Inst., vol. 57, pp. 567-635, pls. 34-54.
- Olsson, A. A.
1931. Contributions to the Tertiary Paleontology of Northern Peru: Part 4, The Peruvian Oligocene. Bull. Amer. Paleont., vol. 17, pp. 1-264, pls. 1-21.
- Schenck, H. G., and R. M. Kleinpell
1936. Refugian Stage of Pacific Coast Tertiary. Bull. Amer. Assoc. Petrol. Geol., vol. 20, pp. 215-225.
- Slodkowitsch, W. S.
1938. Tertiary Polycypoda from the Far East. Paleont. U.S.S.R., vol. 10, pt. 3, fasc. 19, pp. 1-275, pls. 1-105.
- Stewart, Ralph B.
1930. Gabb's California Cretaceous and Tertiary Type Lamellibranchs. Acad. Nat. Sci. Philadelphia, Spec. Publ. 3, pp. 1-314, pls. 1-16.
- Weaver, C. E., et. al.
1944. Correlation of the Marine Cenozoic Formations of Western North America. Bull. Geol. Soc. Amer., vol. 55, pp. 569-598.
- Wiedoy, L. W.
1928. Notes on the Vaqueros and Temblor formations of the California Miocene with descriptions of new species. Trans. San Diego Soc. Nat. Hist., vol. 5, pp. 95-182, pls. 9-21.

NEOPILINA AND THE INTERPRETATION OF THE MOLLUSCA

by

Patrick Milburn
Stanford University, California
(Plate 5)

(Read at the A.A.U.-P.D. Meeting, Redlands, July, 1959)

The discovery of Neopilina (1) and the various papers published since on the remarkable characteristics of this animal (2, 3, 4), have caused a revision of our views about the relations of the mollusks both with other groups and among themselves. It is the author's feeling that many of the present suggestions concerning Neopilina could be better evaluated, and certain of the old theoretical errors could be avoided if

we clearly recognized the nature of theory and the way in which theory should be employed. Some years ago both C. H. Yonge (5) and J. B. Knight (6) published analyses of the relationships of the groups of mollusks and made general predictions of the nature of the ancestral mollusk. These both turned out to be quite similar even though both men had emphasized different chief characters. Predictions made from theories formu-

lated in this way have often proved to be very close to the truth when it became possible to check them. However, the primitive condition as found in Neopilina with probably very few specializations is both more primitive and more elaborate than the theories had predicted. This lack of correspondence, though not very great, is significant and should lead us to examine just why it was, or why it should have been, that we believed our theory to be true before Neopilina.

To do this, we should comment briefly on the nature of scientific theories. As a definition, science is composed of data, observations of one sort or another and explanations of the observations, called theories (7). For the most part, we live our lives in a world composed of these explanatory models which have been accumulated over thousands of years, and which are, though we may not realize it, rather complex and never totally certain inferences. We infer that it rained last night from the puddles on the ground. We infer that atoms exist from the Gas Laws and diffusion. We can never be absolutely certain that our models are wholly correct, but insofar as they satisfy the criteria for theories, we treat them as correct (8). These criteria are: 1) they must explain all available data by the simplest possible means so that there are no unnecessary parts of the theory, and, 2) they must be organized in such a way so that they are, or will be, subject to being tested by experiments or other observations.

Theories about relationships are usually somewhat more uncertain than other theories because we cannot usually directly test them by observing, as in the case of Neopilina, the primitive form, or at least something very close to the primitive form. Both Yonge's and Knight's models were very good, but they could not predict the segmentation of Neopilina, or the post-oral tentacles, or the nature of the primitive gill, any more than a person seeing

the puddles on the ground could have suggested that it hailed the night before. Simply no trace had been left of these things. Unfortunately, many of the older models about similarities were based upon preconceived notions, and not upon what the evidence would suggest. If while reviewing the new picture, we keep in mind that a theory should explain all the evidence by the simplest possible means, and if we endeavor not to be trapped by the older models and interpretations, the probable relationships should be fairly clear.

Bearing in mind, then, that we want to evaluate theories on how well they take into account the available data, we want now to examine the two major areas made clearer by the discovery of Neopilina, 1) the relationships of the mollusks to other groups, and, 2) the relationships among the groups of mollusks.

I

The fact that Neopilina is segmented allows us to choose between the two old theories of whether the mollusks arose from forms like flatworms, or from forms like segmented worms. Besides sharing embryonic similarities, the mollusks are now tied to the segmented animals by having a trace of segmentation.

Lemche, on the basis of respiratory currents (fig. 1), has suggested that the mollusks may be closer to the arthropods than to the segmented worms (3). However, it has been suggested (9) that this similarity is only very general and results from both the mollusks and arthropods having hard dorsal surfaces and that in the last analysis consists of no more than the water flowing from front to back, a feature which is shared with the segmented worms (fig. 1). The suggestion of mollusks and annelids being less close disregards their similarities embryologically and in having trochophore

larvae (10). Further, both the segmented worms, or annelids, and the arthropods add segments posteriorly after emerging from the larval state (11). Mollusks such as Neopilina never show more than a fundamental segmentation (12). Thus, with water-currents showing only a very general similarity, with the annelids and mollusks having embryonic similarities, and with the annelids and arthropods adding segments posteriorly, it is concluded here that the mollusks are examples of forms that were basically segmented, but which added no additional segments and that they are not directly related to either the annelids or arthropods (fig. 1).

The problem then arises as to whether the ancestor of the mollusks had external segmentation or not. Those who believe that the mollusks came from an ancestor that was not externally segmented cannot explain the molluscan foot. However, the method of crawling of certain segmented worms of today suggests how a shortened form that was segmented might have gained a foot. Quite differently from the manner in which flatworms crawl, scale-worms (Polynoids) having a semi-rigid dorsal surface and not using their feet much for locomotion when crawling on the glass of an aquarium make motions much like a snail's or a chiton's (12). This is not to say that mollusks came from these animals, but that these short modern annelids give us a hint of how a foot may have come into being. Although we cannot be certain of this, since it is possible to explain the origin of the molluscan foot in this way,

it is reasonable to suppose that the ancestor was externally segmented.

Also included in figure 1 is a recent suggestion by Lemche that the oral tentacles of Neopilina mostly lost in the mollusca, suggests a connection of the mollusks with mucus-feeding groups like the bryozoans (shown on the chart), phoronids, and perhaps brachiopods (13). The higher forms, evidently as they became adapted to eat larger kinds of food, developed their own mouth parts, the mollusks a radula, the annelids a set of jaws, and the arthropods, mandibular legs. If this suggestion can be supported, it will tie the segmented forms, the mollusks, and the group long ago called molluscoidea into a super-group separate from the flatworms.

II

The problems of the inter-relationships of the classes of mollusks can now be more easily understood also. We no longer have to construct an ancestral form by inference, since we virtually possess one in Neopilina. Both Yonge (5) and Knight (6) envisioned a flat animal as the ancestral form. Neopilina is flat, and from a form like this it is easy to derive the chitons, and solenogastres, at least in principle. However, all of the other groups of mollusks have a heightened shell with a reduced number of gills present (none in the scaphopods). As can be seen in fig. 2, the clams and snails both have their gills confined to a rear space (rear in the extinct gastropods before torsion), and both have the water passing first over the already refreshed blood. Now it was imagined (5), that the ancestor-mollusk

EXPLANATION OF PLATE 5

Figure 1: Relation of Mollusks to other Phyla. A. Hypothetical stage with basic segmentation, mucus feeding. B. Neopilinid, with shell, foot, gill and radula. C. Stage when the remaining groups developed posterior segment multiplication, before divergence of annelids and arthropods. D. Annelid, feet for locomotion, jaws developed. E. Arthropod (trilobite); exoskeleton, walking legs, forward legs into mouth parts. F. Bryozoa.

Figure 2: Relations of the Classes of Mollusks. A. Monoplacophoran like Neopilina. B. Chiton. C. Solenogaster. D. Cephalopod, with section of gill showing water passing first over depleted blood. E. Representing stage with gills at rear and water passing first over refreshed blood (as in pelecypods and gastropods). F. Gastropods, lower representing early extinct form, upper representing modern gastropod, gill showing water passing first over refreshed blood. G. Pelecypods, gills confined to rear, water passing first over refreshed blood. H. Scaphopods, no gills but with an extensive foot, as in the gastropods and pelecypods, and showing embryonic similarities to the pelecypods.

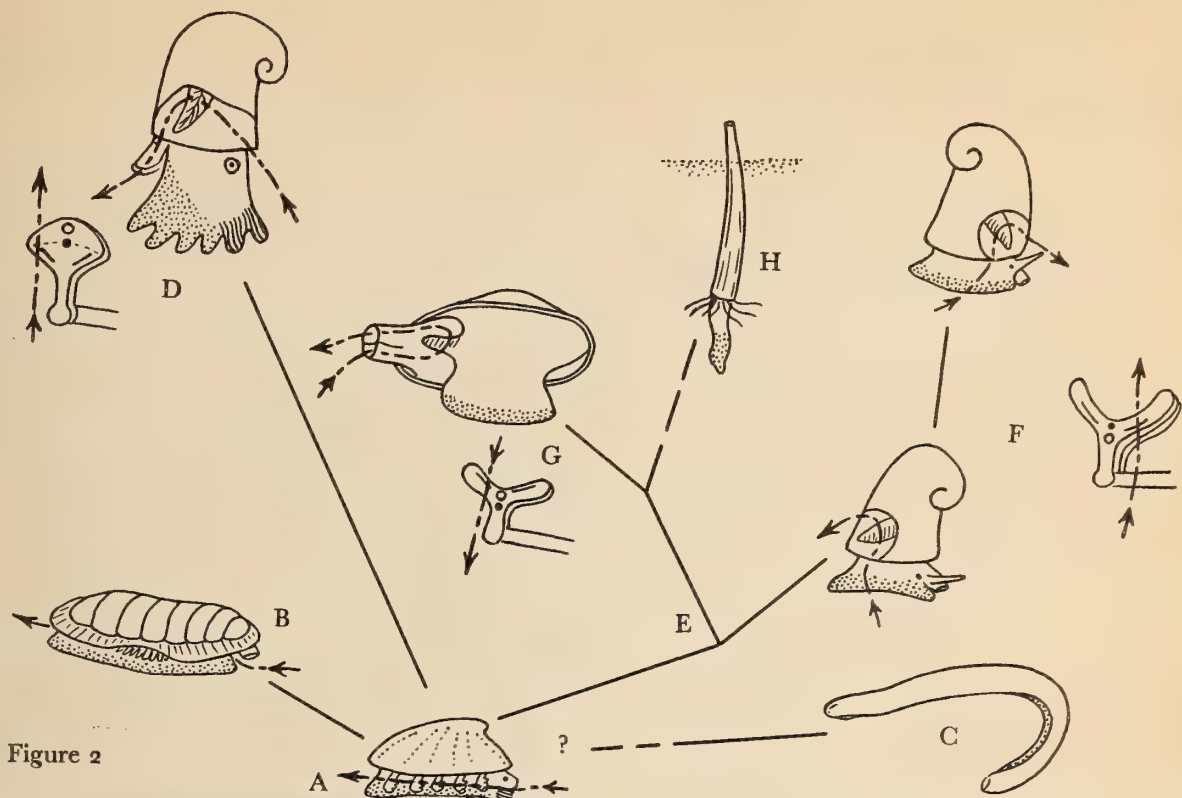
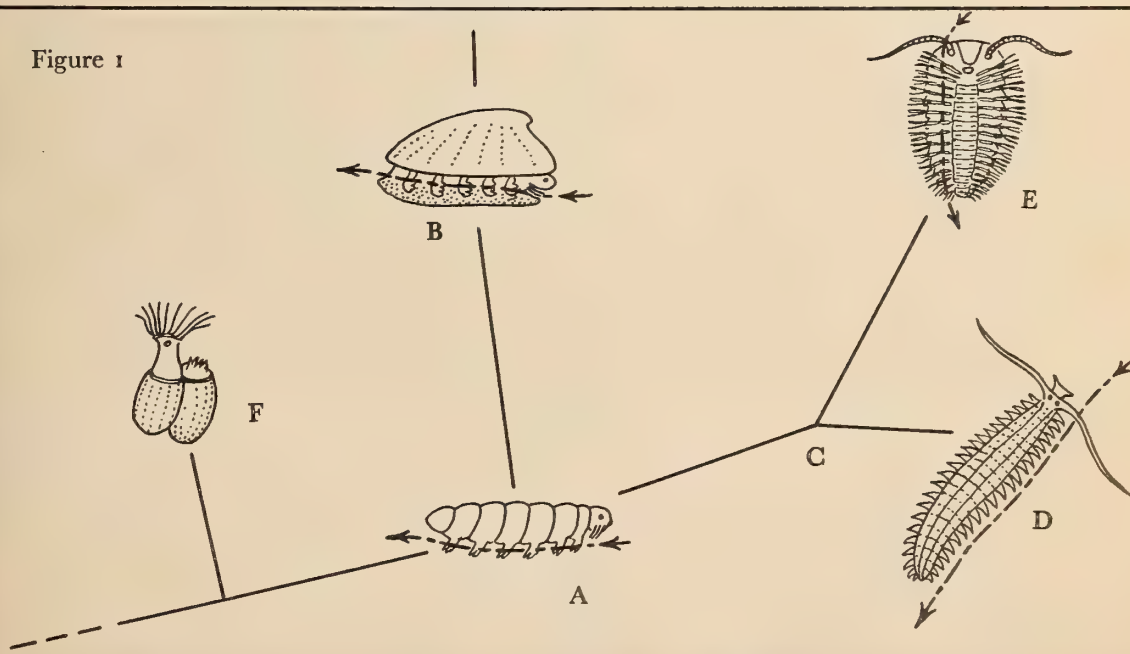








Figure 2

Figure 1



EXPLANATION OF SYMBOLS: Foot stippled. Mollusk gill or walking leg   
 Post-oral tentacle or derivative (*Neopilina*, scaphopods and cephalopods):   
 Arrows indicate direction of water flow. Depleted blood: ● Refreshed blood: ○

Would have possessed a gill chamber and gill arrangement like this. But the cephalopods did not fit into this scheme very well at all. Their gills are situated up along the side, and the water passes first over the old, depleted blood. It was difficult to derive this condition from the clam-gastropod condition. Now that we have Neopilina, and see that the gill-currents were originally more generalized, the problem is overcome. The cephalopod condition and the pelecypod-gastropod condition can be derived separately from the characteristics of Neopilina. This is a much simpler explanation, is theoretically more tenable, and, had Yonge had a form like this to start with, he would most probably never have suggested that the gill-apparatus of cephalopods derived from one like that of gastropods.

Further dissimilarities between the cephalopods and the other advanced mollusks are, that the heart is fused around the intestine in gastropods and is not in cephalopods like Nautilus (12), and a recent suggestion that at least the forward tentacles of cephalopods do not represent the foot at all, but post-oral tentacles as are found in Neopilina and are also represented by the captacula of tooth-shells (2).

With this theoretical consistency, we can now suggest that five groups arose from the ancestral mollusk: 1) the living Monoplacophora, represented by Neopilina, 2) the Polyplacophora, the chitons, 3) the Aplacophora (though it is still not completely certain that these forms are mollusks), the solenogastres, 4) the Cephalopods, and 5) the Gastropoda, Pelecypoda, and probably the Scaphopoda because of embryonic similarities these have to the pelecypods. Further investigations into comparative anatomy and comparative biochemistry and embryology may make it possible one day for these groups to be formalized as super-classes or as sub-phyla.

To summarize: Knowledge about Neopilina allows us to evaluate our theories so that we may achieve a greater the-

oretical consistency. First of all, we may conclude that the mollusks arose from animals with a fundamental segmentation, not from flatworms, and that they are closely related to annelids and arthropods, and perhaps distantly to bryozoans. Finally, it seems likely that the mollusks are divisible into five natural groups: 1) Monoplacophora, 2) Polyplacophora, 3) Aplacophora, 4) Cephalopoda, and 5) the Gastropoda, Pelecypoda, and Scaphopoda.

Acknowledgements: I would like to express my sincere appreciation to Myra Keen for supplying much of the literature, for helpful suggestions and discussion, and for giving me the opportunity to hear Henning Lemche speak when he was at Stanford. Also I would like to express to Donald Abbott for discussion and suggestions, and to S. Stillman Berry for his criticisms, my sincere appreciation. At the same time, while acknowledging my debt to these people, certain errors may have crept in, and for these I take full responsibility.

LITERATURE CITED

1. Lemche, H. Nature 179, 413 (1957).
2. ----- Inter. Con. Zool., Sect. IV paper 22 (1958).
3. ----- Inter. Con. Zool., Sect. IV paper 23 (1958).
4. ----- Inter. Con. Zool., Sect. IV paper 24 (1958).
5. Yonge, C. M. Pallial Organs, aspidobranch gastropods. Philos. Trans. Roy. Soc. London, Ser. B., vol. 232, pp. 443-518. (1947).
6. Knight, J. B. Fossil Gast., Smithson. Misc. Coll., vol. 117, no. 13 (1952).
7. Popper, K. R. Logic of Scientific Discovery, Basic Books, 1959.
8. Reichenbach, H. The Rise of Scientific Philosophy, UC Press. 1951.
9. Keen, A. M. Discussion, June 9, 1959.
10. Hyman, L. H. The Invertebrates vol. 11 (pp. 10-31). McGraw-Hill, 1951.

11. Snodgrass, R. E. Annelida, Onychophora, and Arthropoda.
Smithson. Misc. Coll. 97,
 (1938).

12. Abbott, D. P. Discussion, June 5, 1959.
 13. Lemche, H. Seminar, Stanford University, May 26, 1959.

THE PUZZLING CASE OF Haliotis emmae.

by

Robert R. Talmadge

Willow Creek, California

(Read at the A.M.U.-P.D. Meeting, Redlands, July, 1959)

While working on a population study of Haliotis emmae Reeve, a number of interesting and perplexing taxonomic problems came to light. As the evidence is far from complete, yet certain strong indications are present, this is presented more or less as a preliminary report.

There are strong indications that there is compounded confusion regarding the well known Australian abalone or Sea Ear, the Haliotis emmae. Most collections, both institutional and private, have the basic, common species or subspecies represented. However, material from the peripheral stations that appear to be geographical races is absent, or present only in small numbers. These rather distinct specimens have been classed more or less in a haphazard manner, probably due to the absence of the soft parts for comparative study. The generic classification has also been somewhat complicated. At the present time, shell and animal evidence indicates that we have a rather variable species, that alters from one geographical area to another. It is not known if this distribution is continuous, or represents a number of isolated populations outside the basic range.

The first description that could be found of Haliotis emmae was in Reeve's Conchologica Iconica, Vol. 3, 1846. Reeve referred to the species as emmae Gray, MS., British Museum, and gave the range as "New Holland". As Reeve

referred to all of present day Australia as "New Holland", we must return to his figure to validate which population he was referring to. This is imperative when considering possible racial problems. Fortunately, his figure is an excellent reproduction of the shells that form the basic population inhabiting the coasts from the Eyre's Peninsula, east to Victoria, thence north into New South Wales. Further verification was made by comparison with the lot used by Reeve for his description. Thus, if we decide to use the trinomial in our systematics, this would be the H. emmae s.s.

Now some of the confusion begins. Cotton and Godfrey, 1933, described and named the subgenus Neohaliotis, with scalaris Leach as the type of the subgenus. In this subgenus they placed H. emmae. Later the Neohaliotis was elevated to full generic status in some publications. However in 1939, Wilhelm Wenz, had used the name rubicundas - figured scalaris as the type of his subgenus Padollus, based upon the genus Padollus De Montfort, 1810. Reeve had figured the scalaris and used the name rubicundas, again based upon De Montfort. De Montfort's figure is indistinct, somewhat similar to the scalaris, but his description does not adhere too closely to that species. Actually his description is more like the South African H. parva Linne. The name was finally traced back to Röding

In Bolton, where the name was first used, and a figure in Martini cited as the species. When Martini was checked, the figure was found to be the orange phase of Haliotis parva Linne. Thus rubicundas turns out to be a synonym of parva. So much for the confusion as to the type of the genus in which emmae is placed.

Menke, in his *Molluscorum Novae Hollandiae*, 1843, had described, but did not figure a species from West Australia as Haliotis semiplicata. Evidently Reeve had no knowledge or specimens of this species as he failed to mention the name, nor did he figure the shell. Pilsbry, *Manual of Conchology*, Vol. 12, 1890, referred to Menke's semiplicata as "One of the unidentified species". The shell appears to have been passing, when found, under the name of lauta Reeve, 1846. Perhaps this was based upon an item in the *Conchologica Iconica*, "Taken by Lt. Preston from the Swan River Settlement, New Holland". Evidently there was a mixup in labels, or perhaps the specimen or specimens were lacking in the Hugh Cuming collection when Reeve prepared his monumental work, as such a distinctive shell would have been noted. Cotton, 1952, referred to H. semiplicata as a possible subspecies of H. emmae, with H. lauta Reeve as a synonym. There is no question of the relationship, as both shell and similar animals show that the basic and the West Australian populations belong to the same species. However, comparisons now show that lauta is not a synonym of semiplicata, nor is it the proper name to be applied. This was demonstrated by a direct comparison with the type lots in the British Museum (Natural History). Selected specimens, plus an unsorted lot were compared at my request by Mr. Dance, and it was found that lauta represented the coarsely corded form of the well known coccoradiata Reeve. Thus lauta is a synonym of coccoradiata and not the western race of emmae. Such mix-

ups, especially with locality labels, were not uncommon in the early 1800's.

Through a process of elimination, and comparison of the descriptions of Monke, little doubt remains that semiplicata is the name that was first applied to the western populations of Haliotis emmae. As Menke's name has priority, it would be considered as the proper name under the rules of priority. However, as Menke's specimens can not be located, no definite comparisons can be made. The identification would always be questioned, as there would be a shadow of a doubt. Perhaps Menke might have had a minor pathological example of some other species.

Iredale, 1927, described a new species from Caloundra, Queensland. The type was a beach shell and the animal unknown. For this and other small round Australian species that had been placed with Padollus, he erected the genus Marinauris, Iredale, 1927, with moloculus Iredale as the type. Cotton, 1952, accepted the genus and the species ethologus Iredale, the species in question. In 1943, Cotton described the genus Ovinotis, with ovina Gmelin as the type and placed a species that he had identified as dringii in the Ovinotis. Specimen comparisons now show that ethologus Iredale and dringii Cotton are the same species. Recently specimens of ethologus arrived with the soft parts and shell preserved in alcohol. These were taken on the Keppel Islands north of the type locality. When comparisons were made with other soft parts taken in Australian waters, it was found that ethologus had an animal that for all purposes was identical to emmae and semiplicata. Additional specimens from south of Caloundra, Queensland, gave strong indication of intergradation between emmae s.s. and ethologus. Similar intergradation-al features had been noted from west of the Eyre's Peninsula and West Australia.

It now appears that we have a single species, that may be divided into three geographical races or subspecies.

However, at the present time there are many gaps to be filled with specimens of both shell and animal to complete our distributional pattern. It will also take time to clear up the status of the names of these probable races and to verify which is proper and has priority.

LITERATURE CITED

- 1769, Martini, Neues Syst. Conch. Cab., Nurnberg.
 1798, "Bolton"-Roding, Museum Bolt. Paris.
 1810, De Montfort, Conch. Syst. (2), Paris.

- 1843, Monke, Moll. Novae Holl., Hanover.
 1846, Reeve, Conch. Icon., Vol. 3., London.
 1890, Pilsbry, Man. Conch., Vol. 12., Philadelphia.
 1927, Iredale, Aust. Zool., Vol. 4, (6), Sydney.
 1933, Cotton and Godfrey, South Aust. Nat., Vol. 15, (1), Adelaide.
 1938, Wenz, Hand. der Palaeozoologie, Vol. 1, Berlin.
 1943, Cotton, Trans. Royal Soc. Aust., No. 67, Adelaide.
 1952, Cotton, Proc. Royal Soc. South Aust., No. 1, Adelaide.

THE CONE SHELLS OF TROPICAL WEST AMERICA

by

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(Part of a paper read at the A.M.U.-P.D. Meeting, Redlands, July, 1959)

Most of the cone shells listed below range from the Gulf of California to Panama Bay or still farther South. A few have a limited distribution.

1. Conus fergusonii Sowerby, 1873. The largest species, reaching a length of over 5 inches. Juveniles are yellow and adults white. Fairly common.
2. Conus musicus nux Broderip, 1833. The smallest species, less than an inch in length. Usually listed as C. nux in the literature, but lately Abbott (1957) has suggested that it is a variety of the Indo-Pacific C. musicus. Common.
3. Conus bartischi Hanna and Strong, 1949. (Syn. C. andrangae Schwen-gol, 1955). A beautiful, coronated and speckled species from deep water. Quite rare.

4. Conus brunneus Wood, 1828. Varies in color from dark-brown to brown. Flecked with white. Common.
5. Conus brunneus diadema Sowerby, 1834. Distinguished from C. brunneus by light central band and purple aperture. Not common.
6. Conus ebraeus L., 1758. An Indo-Pacific species that occurs on the Coast of Costa Rica and outlying islands -- Clipperton Island and Galapagos Islands. Rare.
7. Conus gladiator Broderip, 1833. Common on rocks.
8. Conus princeps L., 1758. Common in rocky places. Pink with heavy, longitudinal brown lines.
9. Conus princeps lineolatus Valenciennes, 1832. Has very many fine, longitudinal brown

- lines -- twice as many as C. princeps -- Southern variety, especially in Panama Bay. Not common.
10. Conus princeps apogrammatus Dall, 1910. Color flesh-color to pink, without dark lines. Southern variety, especially in Panama Bay. Not common.
 11. Conus tiaratus Sowerby, 1833. Resembles the Indo-Pacific species C. coronatus. Occurs chiefly on offshore islands. Not common.
 12. Conus orion Broderip, 1833. (Syn. C. drangai Schwongol, 1955 and C. vittatus var. orion). Southern species. Rare. Usually in deep water.
 13. Conus vittatus Bruguiere, 1792. A deep water species. Not common.
 14. Conus perplexus Sowerby, 1857. Varies in shape from short to somewhat elongate. In some localities, the shells are roughened by transverse raised pustules on the rows of black dots. Length, one inch or more. Common.
 15. Conus tornatus Sowerby, 1833. A small, slender species with elevated spire and frequently beaded. Length, one inch or more. Common in deep water.
 16. Conus purpurascens Sowerby, 1833. Varies considerably in shape. Spire obtuse or flattened. Periphery sometimes keeled. Common near shore on rocks.
 17. Conus purpurascens regalitatis Sowerby, 1834. Distinguished from C. purpurascens by uniform dark color and light central band on body whorl. Common.
 18. Conus ximenes Gray, 1839. (Syn. C. interruptus Broderip and Sowerby, 1829). Has brown dots above and below suture. Aperture purple. Common.
 19. Conus ximenes mahogani Reeve, 1843. Smaller and narrower than C. ximenes. Darker blotches present. Dotted lines above and below suture absent. Aperture white. Common.
 20. Conus dalli Stearns, 1873. Three wide, brown, circular bands present. Remainder of shell covered with network of small, white triangles. Somewhat resembles a dark C. textile of the Indo-Pacific.
 21. Conus lucidus Wood, 1828. (Syn. C. reticulatus Mawe, 1823). Color pale lilac with a network of irregular, dark, longitudinal lines intersecting a regular series of transverse lines. Aperture purple. Rare.
 22. Conus patricius Hinds, 1843. (Syn. C. pyriformis Reeve). A pear-shaped cone with leathery, brown periostracum covering the flesh-colored shell. A Southern species. Not common.
 23. Conus archon Broderip, 1833. A heavy, dark-brown species with low spire. Lives in deep water. Rare.
 24. Conus arcuatus Broderip and Sowerby, 1829. Marked with a few dark blotches. Periphery keeled. Spire produced. Not common.
 25. Conus gradatus Wood, 1828. A long, slender cone easily confused with C. scalaris which has a more produced spire. Transverse bands of brown present. Usually found in deep water. Rare.
 26. Conus scalaris Valenciennes, 1832. Has a greatly produced, almost turreted spire. Lives in deep water. Rare.
 27. Conus recurvus Broderip, 1833. Has characteristic, wide, brown, longitudinal blotches. Spire somewhat produced. Common in deep water.

28. Conus regularis Sowerby, 1833.

One of the most common cones of the area, ranging from near shore to deep water. Variable in markings and shape. Transverse rows of dots are characteristic of this species.

29. Conus tessulatus Born, 1778. An Indo-Pacific species recorded several times from offshore islands. Marked with square, orange spots in transverse rows, on a white background.30. Conus virgatus Reeve, 1849.

Pink with a few longitudinal,

brown blotches. Found from near shore to deep water. Fairly common in water of moderate depth.

31. Conus chaldeus Roding, 1798. An Indo-Pacific species - has been taken near Clipperton Island and the Galapagos Islands. Very rare.32. Conus dispar Sowerby, 1833. Not considered a valid species. Appears to be a juvenile form of C. gradatus or C. scalaris.

(Editor's Note: We hope to publish a key to the Cones listed in this article in an early issue of the Veliger.)

THE RED TIDE OF 1958 AT ENSENADA, BAJA CALIFORNIA, MEXICO

by

R. Stohler

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(Plates 6 and 7)

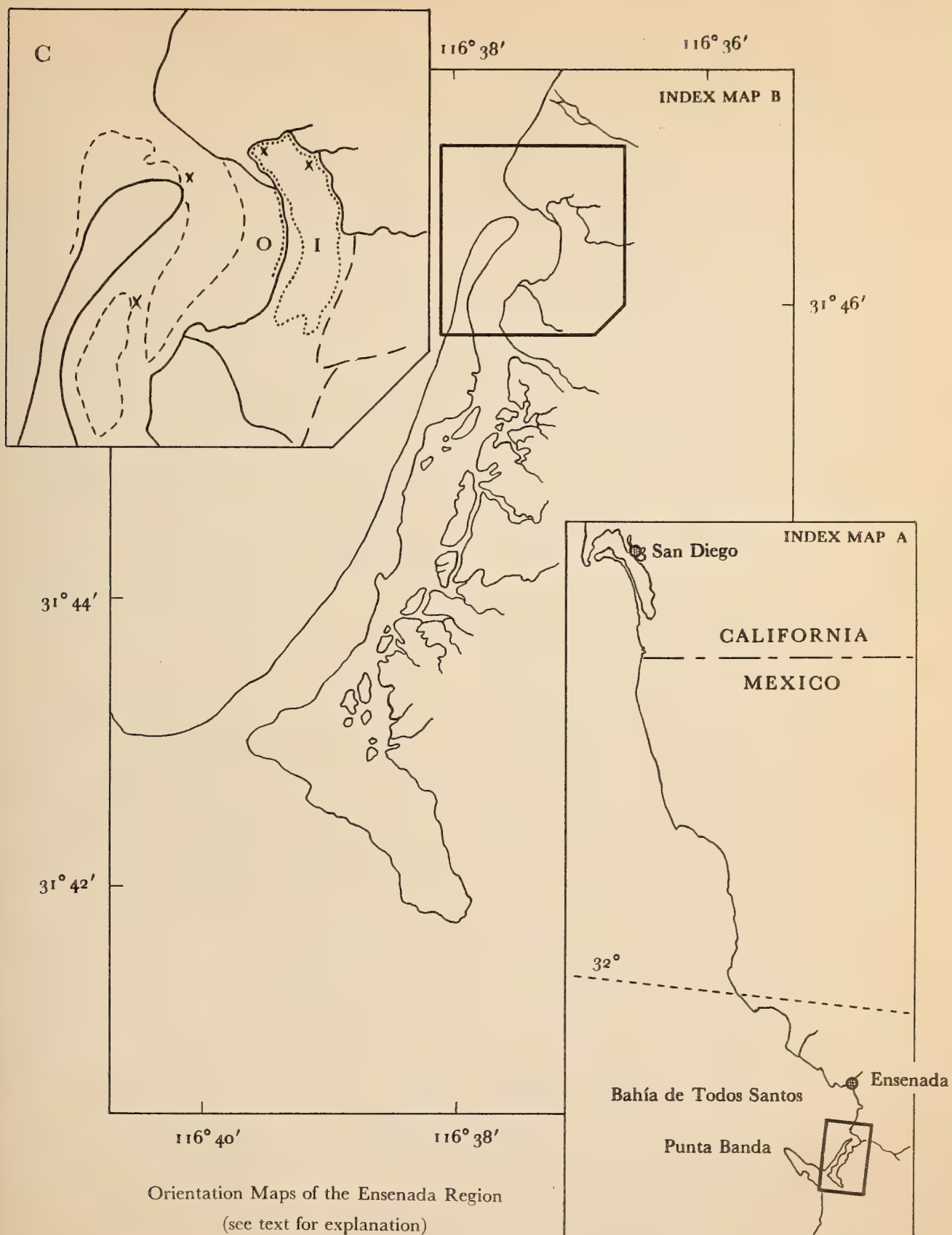
(Presented in abbreviated form at the A.M.U.-P.D. meeting, Redlands, July, 1959)

In connection with a more general survey of the gastropod fauna in California waters by the writer a number of collecting trips have been made into Lower California in order to ascertain, if possible, southern range limits of California species. Among such trips one was made during the weekend of June 15, 1958, in company with Mr. and Mrs. Alan H. Wolfson of San Diego. Aside from collecting at the headland of Punta Banda, a few miles south of Ensenada, a rather careful survey of the Estero de Punta Banda was planned.

As the party approached Todos Santos Bay from the north, it was noticed that the water appeared rust colored rather than the usual deep blue and blue-green; the breakers themselves had a dirty color instead of being capped with pure white foam. However, south of the Bay, as seen from Punta Banda, the ocean had a normal appearing color. While col-

lecting near Punta Banda was very interesting during the low tide of June 14, 1958 (not to be reported on here), nothing unusual was observed. In order to investigate the Estero de Punta Banda (the areas marked O and I respectively on map C, plate 6) a camp was established in the dunes. After dark had fallen, the water showed a fascinating display of phosphorescence; the crests of the waves were a striking luminescent blue and, as the breakers joined, so would the streaks of blue light coalesce. Nor was the luminescence restricted to the water; on the sand each step would cause a run of phosphorescence ahead of the walker and the tracks would remain brightly outlined by the same color light for several seconds after a person - or a dog - had passed by.

During the low tide on the morning of June 15 the two areas already re-



ferred to were examined. The following species of mollusks were collected, some of them being present in great numbers.

Outer Portion (O):

Acmaea conus Grant
Acmaea depicta (Hinds)
Astraea undosa (Wood)
Chione californiensis (Broderip)
Chione undatella (Sowerby)
Conus californicus Hinds
Crepidula onyx Sowerby
Donax californicus Conrad
Donax gouldii Dall
Haminoea vesicula (Gould)
Laevicardium substriatum (Conrad)
Modiolus rectus (Conrad)
Nassarius tegulus (Reeve)
Olivella baetica Marrat in Sowerby
Olivella biplicata (Sowerby)
Pecten l. latiauratus (Conrad)
Polinices recluzianus imperforatus Dall
Pyramidella mexicana Dall and Bartsch
Tricolia compta (Gould)
Vesica gouldiana (Pilsbry)

Inner Portion (I):

Acteocina californica Willett
Cerithidea californica (Haldeman)
Chione californiensis (Broderip)
Chione undatella (Sowerby)
Cuningia californica Conrad
Nassarius tegulus (Reeve)
Polinices recluzianus imperforatus Dall
Pyramidella mexicana Dall and Bartsch
Tagolus californianus Conrad

It should be mentioned that no digging tools were available and therefore all collecting was limited to picking up specimens with the hands.

During collecting, especially in the inner portion, a very strong, unpleasant odor was noticed; this odor is characteristic of decaying marine invertebrates. And, indeed, a large number of the species listed were represented by numerous, recently dead individuals; the only species not so affect-

ed seemed to have been those that can normally withstand extreme temperature variations, such as the California horn shell, Cerithidea californica. Many other invertebrates were observed lying about, decomposing or dying. It was especially weird to notice large numbers of Sipunculus nudus Linnaeus almost completely exposed, with, perhaps, only the hindmost quarter of the body still in the burrow. Very few of these worms were still living but were unable to react in their usual manner when touched; they merely wriggled very little and did not attempt to withdraw. Also many dead fish of various species were seen. To be sure, many fish were still swimming around, particularly in the outer portion, but the general picture was one of death and decay. Among the snails it was not uncommon to have the operculum slip off when it was inadvertently touched. One other observation seems worth mentioning, namely that the specimens of Tagolus californianus seen were all dead and in advanced state of decomposition; they seemed to be lying adjacent to their original holes and one obtained the impression that they had come out of them and then died.

Perhaps it should be stated that, although we did not have any thermometers with us, nevertheless we were all impressed by the very warm water; also it seemed to me that the temperature in the inner portion was considerably higher than in the outer portion of the Estero.

After returning to La Jolla I reported these observations to Dr. E. W. Fager of the Scripps Institution of Oceanography. On June 17 a small team of students and technicians was sent to the same locality. The team consisted of Mr. James S. Kittredge, Mrs. Anne H. Dodson, Miss Jacqueline Kentner (now Mrs. Gaylord Miller) and Mr. C. Mitchell; their objective was to obtain samples of the water, make observations on temp-

orature and salinity and attempt to ascertain the extent of the area affected, both horizontally and vertically. After their return they prepared a report which Mr. Kittredge made available to me and from which the following excerpts are taken.

Three stations were established in Todos Santos Bay (not marked on the accompanying maps); station I was approximately 6 miles out of Ensenada Harbor, due north of Punta Banda; station II was approximately 3 miles out of the Bay, bearing N 60°, southwest of Ensenada coming into the harbor; station III was ½ mile out of the harbor returning to dock.

The procedure followed was the same at all three stations:

Temperatures were taken by J. Kittredge with the thermosonde temperature recorder at one meter intervals, except where the thermocline was encountered, when the interval was shortened to 25 cm. The temperature readings in turn determined the depths at which water samples were taken, with a Van Dorn sampler. Duplicate samples collected were distributed, one set to Mrs. Dodson (Botany), the other to Mr. Klein for salinity analysis and after that on to Mr. Jones (Microbiology). Depths sampled were as follows:

at station I: 0 m., 1 m., 2 m., 3 m. and 4 m.; at station II and at station III: 0 m., 1 m., 3 m., 5 m., and 7 m.

In the discussion of their report, the following paragraph is found, "The owner of Gordo's Sportfishing Boats reported that up to June 12, they had been able to hold sardines in their bait receivers (at least two weeks of red tide). The night of the 12th of June they lost all the bait in the receivers and the following morning, a boat came in with full tanks and the sardines died within a few minutes after the boat entered the heaviest red water inside the breakwater. The fish curled into semicircles as they died. The following week the receivers were moved outside the breakwater and they were able to hold bait there (where counts of 10,000,000 cells/liter were recorded)."

The team then went on to make some observations at various spots inside the Estero de Punta Banda (marked with x on map C, Plate 6) and I quote the following paragraph from this part of the report:

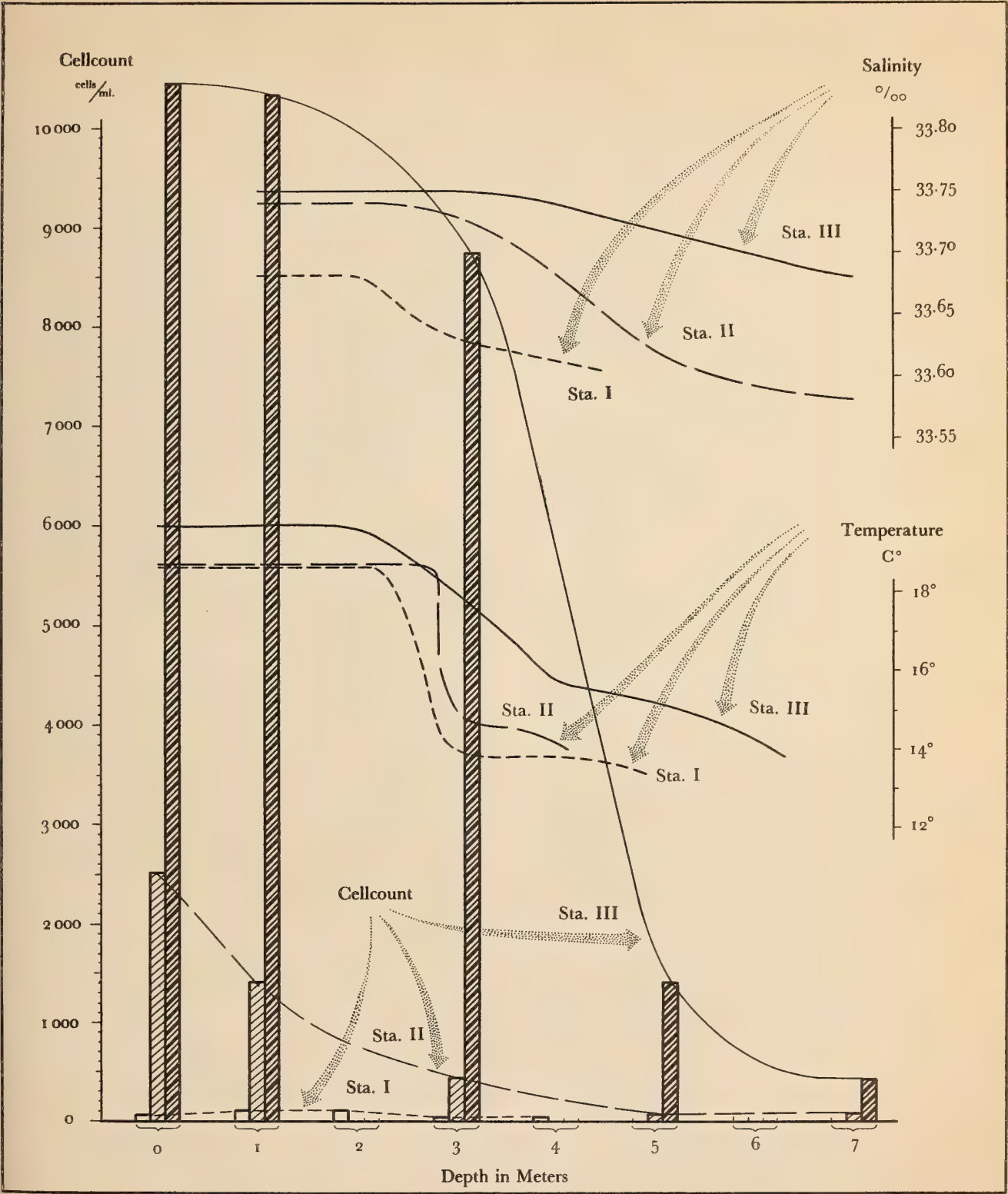
"Many dead Chione and Tagelus were found in the small lagoon to East of main Estero (the part I called Inner Portion, R. S.). Only about 1% of the Chione were alive. Numerous Cerithidea californica were found on the spit between the two areas as well as associated with the previously mentioned mollusks. Of these horn shells, about 95% were living. On the sand spit nearest to the ocean, a few live Donax Gouldi were found."

Temperatures measured at various spots (see map C, Plate 6) ranged from a low of 21.35° C to a high 29.4° C. The salinity observed was well within the range of normal.

Mrs. Dodson identified the organisms in the "red water" and made counts for the different samples taken. The results are shown on plate 7; the bars represent cell counts of the incriminated organism while the curves give temperature and salinity at the three stations in Todos Santos Bay. Mrs. Dodson also made a differential count of one milliliter of a sample taken inside the Harbor; her results were: 20 Fragilidium sp.; 2 Ceratium sp.; 1 Ceratium furca; 1 Peridinium depressum; 15,414 Gonyaulax polyedra.

My own earlier work on mussel poisoning predisposed me to suspect that we were having another of the poisonous red tides. The many dead organisms as well as the accounts of bait fishermen about the sudden death of the sardines seemed to me an indication that this assumption was correct. However, after the organism was identified, another explanation had to be looked for. And, perhaps, the explanation is surprisingly simple.

Due to the red pigment of Gonyaulax polyedra the infra-red rays of the sun were absorbed; this, in turn, caused the temperature of the water to rise to an abnormally high degree. The



See text for explanation

high temperature of the water in its turn reduced the ability of the water to dissolve oxygen and the extreme density of the dinoflagellates further helped reduce the normal oxygen content.

The graphs on Plate 7 were constructed from the data supplied by Mr. Kittredge. The curves for salinity show a more or less gradual decline toward the deeper water; however, it is interesting to note that the salinity was slightly higher at Stations II and III than at the station furthest away from shore. The temperature curves, on the other hand, deserve a closer scrutiny. It will be readily perceived that there was a strong and abrupt thermocline at station I and at station II, while at station III the decrease in temperature was much more gradual and slow.

The bars indicating the cell counts per milliliter show a close correspondence to the subjective appraisal of the water color made by the members of the team and also by our own party a few days earlier. Further from shore the water appeared normal in color and the cell count at station I, at various depths, was small, though larger than might be expected in a normal year. At station III the population of Gonyaulax reached an astounding density of approximately 10 million cells per quart of water (10'460'000 per liter) at the surface, decreasing only slightly in the first ten feet to about 8 million cells per quart (8'760'000 per liter). This decrease accelerated only relatively slightly to drop to a count of a little less than 1½ million per quart at 15 feet

and to about 2/5 of a million at 21 feet. The thermocline, because of the heat-absorbing quality of the red organisms, was therefore not as sharp as it would normally be.

The high density of Gonyaulax at the surface of the water at station III was exceeded by that of a sample taken inside the Harbor where the number was over 15 million per liter (actual count by Mrs. Dodson: 15'414 per milliliter).

Organisms with a normally relatively high oxygen requirement rapidly perished (such as some fish, perhaps, and some of the more sensitive mollusks); their decaying bodies rapidly fouled the water which aggravated, of course, the whole situation. Furthermore, many of the invertebrates are known to be extremely sensitive to temperature increases and these die rapidly once a certain critical point is reached or exceeded. This latter condition undoubtedly applies to many clams and snails. On the other hand, Cerithidea californica remaining essentially unaffected is not surprising to him who is familiar with the normal habitat of this species: shallow pools and lagoons, where the temperature of the water may rise to unusual heights during a warm summer day.

It is interesting to note that this particular "red tide" persisted for a long period and gradually moved north, reaching the San Diego area in early August. Fortunately the organism responsible for this spectacular and, in a way (at least at night) very beautiful, phenomenon was not poisonous, a fact borne out negatively by the lack of human deaths attributable to the eating of "poisonous" sea food.



NOTES AND NEWS:

MAGNETIC PROPERTIES OF CHITON RADULAE

by

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The radulae of chitons exhibit magnetic properties and can be readily picked up by a magnet. The substance responsible for this property is located in the dull black tips of the larger teeth of the radulae. Analysis for common magnetic substances yields a positive test for iron and negative tests for cobalt and nickel, suggesting that the specific action is ferromagnetism. The teeth can be strongly magnetized readily to the extent that they will cling to steel dissecting needles and scalpels. They do not appear to have much intrinsic magnetism as a permanent characteristic.

The original observation of the magnetic properties of chiton radulae was made by Spencer Thorpe, and the distribution of the characteristic and its properties are currently being studied by him and by Dustin Chivers, both students at San Francisco State College.

Preliminary observations on the distribution of this characteristic by the author show that the radula may be picked up by a magnet in Callistochiton crassicostatus Pilsbry, 1892; Cryptochiton stelleri (Middendorff, 1846); Cyanoplax hartwegii (Carpenter, 1855); Ischnochiton radians Carpenter, 1892; Katherina tunicata (Wood, 1815); Mopalia ciliata (Sowerby, 1840); Mopalia lignosa (Gould, 1846); Mopalia muscosa (Gould, 1846); Placiphorella velata Carpenter, 1878; and Tonicella lineata (Wood, 1815). The characteristic is not found in Diodora aspera (Eschscholtz, 1833); Megatebennus bimaculatus (Dall, 1871); Haliotis cracherodii Leach, 1817; Haliotis rufescens Swainson, 1822; Acmaea (several species); Dendrodoris fulva (Mac Farland, 1905); or Loligo opalescens Berry, 1911.

The fact that magnetism is demonstrated in many different specimens of many species from many localities and that individual teeth dissected off with non-ferric and non-magnetic tools exhibit this property eliminates the possibility that ingested iron substances might be adhering to the teeth to elicit this response. A possible explanation of the source of this magnetic material lies in the ingestion of algae, some species of which are known to contain particulate iron.

Range Extension of

Acmaea fenestrata cribraria

by

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According to Keen (1937), the southern limits of the subspecies Acmaea fenestrata cribraria Carpenter is 35° North Latitude. More recently, Stohler (1959) reported collecting A. f. cribraria in Lower California at approximately 32° 05' N. On June 23, 1959, in the company of Mr. Peter Pickens, I collected in the intertidal on the south side of Punta Banda, Lower California (31° 45' N.). The express purpose of the trip was to obtain A. limatula for physiological studies aboard the Scripps ship "Orca" and for subsequent studies at Scripps Institution of Oceanography. Five of the animals, randomly collected, were tentatively identified as A. pelta at the time of collection; R. Stohler re-identified them as A. f. cribraria.

The south side of Punta Banda is a well known area of cold water upwelling; the temperature of the inshore waters, at the time of collection, was 14.5° C. The spotty southern distribution of Acmaea f. cribraria, in areas of cold water upwelling, suggests the possibility that the subspecies may extend still further south of the present range of extension.

Keen, Myra A. 1937. An abridged check list and bibliography of west North American marine Mollusca. Stanford Univ. Press.

Stohler, R. 1959. Range extensions of some west N. A. marines. Nautilus 72 (4):127-130

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American Malacological Union
Pacific Division
Meeting dates announced for
1960

Arrangements have been completed for holding the 13th annual convention of the A. M. U. - P. D. beginning June 22, 1960 at Asilomar, Pacific Grove on Monterey Bay. The tentative program includes, in addition to the usual events:

Wednesday, 3:00 P.M. - Registration and sign-up for various events.

Thursday, 4:30 A.M. - field trip to Elkhorn Slough.

Friday, 5:00 A.M. - field trip to rocky area near Pacific Grove.

Also several informal gatherings are planned for each day to enable participants to become better acquainted with each other. Further, if interest is shown, a shell auction or a shell bourse might be arranged.

Sign-out after Saturday noon dinner.

Cost of the three day program, including accomodations and 9 meals: \$25.00 to \$34.00 per person, 2 or more to a room. The price depends on housing chosen.

Details will be sent early next year to all members of the A.M.U.-P.D. and other interested parties may obtain information by writing to Mrs. Lucille Zell-ers, Secretary, 714 Elm Street, El Cerri-to, California. Please, enclose self addressed, stamped envelope.

R. Stohler, Chairman

BOOKS, PERIODICALS, PAMPHLETS

- - -

Book Review

Type specimens of marine mollusca described by P. P. Carpenter from the west coast (San Diego to British Columbia).

PALMER, Katherine Van Winkle.
Memoir 76, Geol. Soc. Amer.,
VI-376 pp., 35 pls. December 8,
1958.

This book is not one to be read from cover to cover and the reader who looks to it for a more or less popular account about the shells described by Carpenter is certain to be disappointed. However, the serious student of shells from the Pacific Coast of America will find in this work a very rich source of essential information, painstakingly assembled and most beautifully organized. Dr. Palmer has here assembled information on the whereabouts of the type specimens of the many species first described by Carpenter and so thorough was her search that it may be assumed that the types which she could not locate are, indeed, lost forever.

In many instances her research work rivals the suspense of a Sherlock Holmes story. Of great importance also is the fact that excellent photographic figures are now available of the still existing type specimens of the Carpenterian species, a fact which will assist tremendously in clearing up a great number of uncertainties. This book which is the culmination of many years of devoted work is indeed of inestimable value to the student of the West Coast mollusks and it seems to be so thorough that even an occasional typographical error will be checked by the user of the book before he accepts it as such an error. It may be said truly that this book should be in the library of all students of California mollusks, whithersoever dispersed around the globe.

H. Hunt

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DANGEROUS MARINE ANIMALS - Bruce W. Halstead, M. D; Cornell Maritime Press. 176 pp. 123 halftone photos, 34 line drawings, 4 maps. 1959.

In this guide to dangerous marine animals that bite and are poisonous and venomous to man, the author fully illustrates these marine organisms - their noxious effects, treatment, and of prime importance, how to avoid them. The world-wide geographical distribution and habits are given for each of the Dangerous Marine Animals. The facts presented are the result of more than fourteen years' medical research on dangerous marine animals. The bulk of this research was conducted for the Armed Forces of the United States. Personal field research by the author was amplified by medical histories of individuals and institutions over a period of several hundred years. The book is profusely illustrated and shows the various species in true form in considerable detail. The tooth structure of biting marine organisms and the venom apparatus of stinging animals are shown.

The book is divided into four parts: Dangerous Marine Animals - Our knowledge of the Past; Marine Animals that Bite; Marine Animals that Sting; Marine Animals that are Poisonous to Eat. Technical material has been kept to a minimum in order to be of greater value to the layman. However, practical advice is presented which will be of value to the biologist, skindiver, shell collector, first-aid worker and physician, since treatment of disorders resulting from dangerous marine organisms are given which in each case constitute the latest accepted practices. We feel that this book should be carefully read, if not owned, by all those whose vocation or avocation brings them into close contact with the sea.

R. Stohler

METHODS & TECHNIQUES.

Editor's note: With the current number of the Veliger we are opening two new columns. For the column on Methods and Techniques we welcome papers dealing with any type of method pertaining to the collecting, preparing, studying, maintaining, etc. of mollusks; papers on techniques relating to mollusks may cover a wide field of special interests, such as still photography, cinematography, microtechnique, etc. The only limitation imposed will be that information must be complete and the techniques and methods must be capable of duplication by anyone carefully following the description given.

INFORMATION DESK.

The second new column, entitled Information Desk, will contain articles dealing with any aspect of collecting and identifying shells, how to build up a collection or any other problem encountered by our readers. In contrast to the previous column, articles here do not necessarily contain new and original materials, but the column is intended to be useful to the beginning as well as, at least occasionally, to the advanced collector and student. Questions to the editor are invited. As the first contribution to our new column we are starting to publish a series of articles dealing, successively, with the accessioning, labelling and cataloguing of private collections. This series is in response to some questions reaching the editor as an aftermath of the meeting of the American Malacological Union, Pacific Division at Redlands in July, 1959.



How to Build a Private Collection Which is Scientifically Valuable.

by

R. Stohler,

Department of Zoology

University of California, Berkeley

Part I: Introduction.

It is a sad experience that often large collections reach some public museum or other, collections built up over many years and on which sometimes very large sums of money have been expended, and yet to the curator of the museum these collections represent nothing but a headache. The material must be accepted, the gift must be acknowledged and yet the shells end up in a give-away box or in an ash barrel. What simple procedures could have made the same collection one that would have tempted the curator to shout for joy when it reached him?

The difficulty can be expressed in an axiomatic statement; a shell without proper information is worthless. Thus arises the question: what is the proper information that should accompany every specimen?

Perhaps the most important bit of information about any specimen is the exact locality at which it was found. By exact locality is meant, of course, an indication as to the very spot on a good map where the place is represented. Thus, a shell bearing the locality indication "California" is worth considerably less, scientifically speaking, than it would be if it were accompanied, for example, by the statement "Moss Beach, San Mateo County, California". The value would increase if we also had the exact date when the shell was collected, since some species may be quite seasonal and we become aware of that fact only over a period of time. Since there may be also climatic factors affecting the

occurrence of a species, the date allows an investigator many years later to check on conditions prevailing at the time the specimen was collected. More valuable still is the specimen which is accompanied by information as to the ecological niche in which it was found. Thus, at Moss Beach in San Mateo County we find high rocky flats, deep tide channels, sandy areas, high tide pools, medium high tide pools, etc.; in short, we find a great number of different living conditions offered. For many species it is fairly well known that they can be found only in a very well defined, special ecological niche; however, we are still lacking that information for many other species. The collector who will pay close attention to the exact environment in which he collects his specimens and who will make a careful note of his observations and furthermore will pass this information on together with the specimen may actually make a very important contribution to science. Perhaps it should be mentioned that the association of one species of animal with another particular animal species or with a particular kind of plant is part of the ecological niche of that species.

Other bits of information of value to the scientific worker are the name of the collector and the name of the person who identified the specimen.

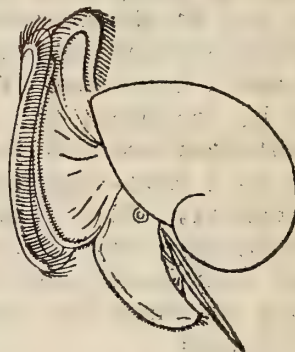
While it may not be necessary for the shells themselves, nevertheless a good collector will pay attention to colors of the animals observed and make notes on these. This is particularly essential for such forms as the Nudibranchs whose beautiful colors so rapidly fade in the preservative. Unfortunately, most scientists in the past have neglected to observe the entire animal and contented themselves with a description of the shell alone. The shell

of a mollusk is certainly a characteristic structure, but it should not be considered the most important from a taxonomic point of view. We need recall only the importance of the structure of the reproductive apparatus of the land snails for a case in point. In brief, the more details of information accompany a specimen, the greater its ultimate scientific value.

The importance of the information accompanying a specimen cannot be over-estimated; however, it must be borne in mind that the information without the specimen is equally incomplete as is a specimen without information. The reason for this is fairly obvious. The same species may (and, in most cases, does) occur in different localities. However, in the different localities there may be very subtle differences which become apparent only after a very careful study. Thus, it is clear, specimen and information are equally important and should be inseparable. How can we insure that no loss occurs?

Many collectors take with them into the field a set of prepared numbers, as well as the usual collecting gear; another important piece of equipment for these persons is a good notebook. In the latter is entered under a given number all the information pertinent to the animal, and the same field number is, in some fashion, affixed to or included with the specimen. The field numbers are written or printed with a very high quality ink (insoluble in alcohol or other preservatives) on a very high quality paper. These are then the numbers prepared well in advance. After the collector returns to the laboratory the field notes may be transcribed onto permanent labels to go with the specimens.

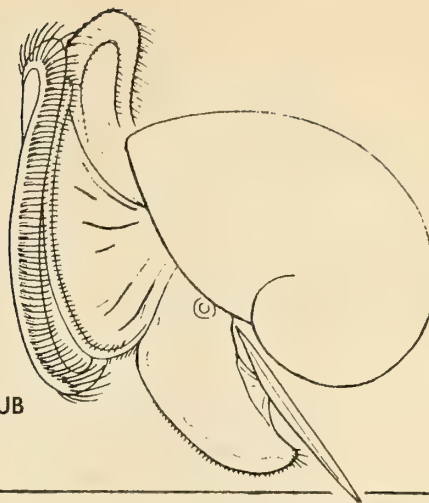
The next step to insure the value of the collection is the accessioning of the specimen or specimens. This will be discussed in a future number of the Veliger.



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THE VELIGER is open to original papers pertaining to any problem concerned with mollusks from the Pacific Region.

This is meant to make facilities available for publication of articles from a wide field of endeavor. Papers dealing with ecological, morphological, anatomical, physiological, distributional, taxonomic, etc. aspects of marine, fresh water or terrestrial mollusks from any region bordering on or situated within the Pacific Ocean, will be considered. Even topics only indirectly concerned with mollusks may be acceptable.

It is the editorial policy to preserve the individualistic writing style of the author; therefore any editorial changes in a manuscript will be submitted to the author for his approval, before going to press.

Short articles containing descriptions of new species or lesser taxa will be given preferential treatment in the speed of publication provided that arrangements have been made by the author for depositing the holotype with a recognized public Museum. Museum numbers of the type specimens must be included in the manuscript. Type localities must be defined as accurately as possible with geographical longitudes and latitudes.

Short original papers, not exceeding 500 words, will be published in the column "NOTES & NEWS"; in this column will also appear notices of meetings of the American Malacological Union, as well as news items which are deemed of interest to our subscribers in general. Articles on methods and on techniques will be considered for publication in another column, provided that the information is complete and techniques and methods are capable of duplication by anyone carefully following the description given. Such articles should be mainly original and deal with collecting, preparing, maintaining, studying, photographing, etc., of mollusks or other invertebrates. A third column, entitled "INFORMATION DESK," will contain articles dealing with any problem pertaining to collecting, identifying, etc., in short, problems encountered by our readers. In contrast to other contributions, articles in this column do not necessarily contain new and original materials. Questions to the editor, which can be answered in this column, are invited. The column "BOOKS, PERIODICALS, PAMPHLETS" will attempt to bring reviews of new publications to the attention of our readers. Also, new timely articles may be listed by title only, if this is deemed expedient.

Manuscripts should be typed on a high grade white paper, 8½" by 11", double spaced and accompanied by a carbon copy.

SOME QUANTITATIVE ASPECTS OF PREDATION BY MURICID SNAILS
ON MUSSELS IN WASHINGTON SOUND

by

Oscar H. Paris

Department of Zoology, University of California, Berkeley, California.
(Plate 8)(Work done under partial support of a National Science Foundation Grant,
No. G-3298, to the Department of Zoology, University of Washington.)

The mussel-barnacle community of the rocky intertidal area offers the ecologist certain advantages for the quantitative study of trophic relationships. The greater part of the biomass of the community is incorporated in relatively few sessile or sedentary species. These dominant organisms lend themselves well to observation, sampling procedures, and experimental manipulation. The community is accessible for direct study at low tide, and under appropriate circumstances field observations may be made even during high tide. Investigations of food-web relations in any natural community provide not only information of interest in the biology of the organisms involved, but are also a step toward an understanding of the dynamics of the ecosystem in which they live.

In the summer of 1958, while at the University of Washington's Friday Harbor Laboratories, the author had the opportunity to make a pilot study of the predatory activities of three species of muricid snails, Thais canaliculata (Duclos), T. lamellosa (Gmelin), and T. emarginata (Deshayes), in mussel and barnacle beds of Washington Sound. The mussel beds consisted of individuals of Mytilus edulis Linnaeus or M. californianus Conrad, according to location; barnacles present were Balanus cariosus (Pallas), B. glandula Darwin, Chthamalus dalli Pilsbry, and perhaps B. crenatus Bruguiere.

Since the last cannot be differentiated from B. glandula except by dissection, all barnacles of this type were classified as B. glandula, which according to Henry (1940) is the more common. The mussels and barnacles in these communities serve as the principal source of food for the three species of Thais. In addition the seastar Pisaster ochraceus (Brandt) preys upon mussels and barnacles at the lower level of the community.

Observations were made at two locations. One study area was on Turn Rock, located in San Juan Channel, east of Turn Island, at 48°32' N. lat., 122°58' W. long.; the other was on a rocky spit projecting from the north shore of Kanaka Bay, which opens from San Juan Island into Haro Strait, at 48°29' N. lat., 123°05' W. long.

Extensive beds of Mytilus edulis occur on Turn Rock from a tidal level of about 3.5 feet down to slightly below 0 feet. These frequently form a mat of individuals, bound together by byssal threads; the mussel bed ends rather abruptly at its lower margin. Underlying the Mytilus mat is a bed of living Balanus cariosus; this extends beyond the mussel mat to a tidal level of about -1 foot, where it likewise ends abruptly. Below the lower margin of the community a mass of broken Mytilus and Balanus shells rapidly gives way to an essentially bare, rocky substrate. Balanus cariosus also forms exten-

sive beds at tidal levels above the mussel mat, with less numerous B. glandula and Chthamalus dalli occurring above mid high water. Although subjected to strong tidal currents, surf action at Turn Rock is slight, except perhaps during severe storms.

At Kanaka Bay, on the other hand, surf action is moderate to heavy. The shore is more precipitous than at Turn Rock, but the intertidal area less extensive. The same species of barnacles occur here as at Turn Rock, and the mussel on the Haro Strait side of San Juan Island is Mytilus californianus. Neither the barnacles nor M. californianus form extensive beds here; the more irregular spatial distribution is perhaps related to the broken nature of the boulder-strewn shore, which presents a substrate with varying degrees of exposure to wave action and dessication. In the shallow depressions and crevices on the more horizontal surfaces of rocks most exposed to surf action, small beds of M. californianus (15 to 30 mm. in shell length) occur. Scattered large individuals (up to 150 mm. or more) may be found in sheltered crevices and tide pools.

Thais emarginata occurs at the highest tidal levels in both study areas, at Turn Rock being most abundant above the Mytilus beds. Thais canaliculata overlaps slightly the lower part of the range of T. emarginata; at Turn Rock its distribution extends across the Mytilus beds to the lower limit of the Balanus cariosus beds which fringe the bottom of the community. Thais lamellosa is restricted to that part of the community lying below the zero tide level. At Turn Rock its range extends below the bottom margin of the mussel-barnacle community; the precipitous shore and the active surf

prevented a comparable observation at Kanaka Bay. At the latter site T. lamellosa could be found higher than at Turn Rock, in shaded fissures of the upper intertidal.

Several approaches were used to obtain information about prey-predator relations in the two study areas. Observations were made of instances of predation in the field, at which time the species and size of both predator and prey were determined. Quadrat counts of predator and prey individuals were made at three tidal levels at Turn Rock, and data were obtained on size distribution of the predator population and on the Mytilus which had been killed by them. Finally, a collection was made at Turn Rock of all three species and their prey; these were brought alive to the laboratory and maintained in seawater, where observations on predatory activity over a period of three weeks were possible. Some of the results of these various efforts will be considered.

Searches for feeding predators were made at Turn Rock on seven occasions between August 2 and 18; three such periods of search were conducted also at Kanaka Bay. Snails found on mussels and barnacles were pulled away to determine whether they had been feeding. Thais feed by drilling holes through the shells of their prey (Jensen, 1951); the presence of such a hole through a Mytilus valve, beneath the head of a snail, was considered evidence of the snail's feeding. Often the proboscis could be seen being withdrawn from such holes as the snail was pulled away.

Thirty-two instances of predation by Thais canaliculata on Mytilus edulis were observed at Turn Rock, and T. lamellosa preying on Mytilus was observed in 18 instances. Mean size of the mussel prey selected by T. canaliculata was 37 ± 1 mm. (mean \pm standard

error of the mean), and of those selected by T. lamellosa 32 ± 2 mm. The mean size of the mussel prey selected by T. emarginata was only 17 ± 4 mm.; this is based on five observations. Because the variance of the data for T. emarginata was significantly greater than those for the other two snails, non-parametric methods were used to determine whether the data in the three samples could be considered as having identical distributions. Using the Kruskal-Wallis one-way analysis of variance by ranks (Kruskal and Wallis, 1952; Siegel, 1956), an H value of 10.035 was obtained. Referral to the chi-square table showed this to be significant ($P = .01$), indicating that the distributions of the populations from which the samples were taken are not all identical. A Mann-Whitney test (Siegel, op. cit.) showed that the mussels killed by T. emarginata were significantly smaller ($P = .001$) than those killed by T. lamellosa. No difference was detected in the data for T. lamellosa and T. canaliculata. These results suggest that Thais canaliculata and T. lamellosa prey upon the same size class of Mytilus, while T. emarginata selects a smaller size class. Although this difference could have resulted from a sampling artifact, other evidence given below also supports the conclusion reached here. Frequency distributions of the size of mussels preyed upon by the three species are compared in Plate 8, figure 1.

Whereas dead, drilled Mytilus edulis shells, which were still attached by their byssal threads, were extremely common at Turn Rock, at Kanaka Bay only ten drilled M. californianus shells were found in the entire research area. The latter had been washed up on the beach. Probably surf action breaks free dead shells at Kanaka Bay, so that they do not remain as evidence

of predatory activity. No Thais was seen on beds of small Mytilus located on exposed horizontal or gently sloping surfaces of rocks at Kanaka Bay, nor was any observed on the scattered large individuals of Mytilus occurring in the more protected areas. It is suggested that surf action may prevent predation by Thais on these exposed surfaces, since generally these snails were not found in such areas. Perhaps in the more protected areas the snail population eliminates most of the mussels, with only a few escaping predation until large enough no longer to be subject to attack by Thais. Observations to corroborate or negate this hypothesis are needed.

On barnacles, evidence of predation was considered established if a hole drilled through the parapet was apparent when a snail was pulled away from a barnacle, or if the scutal plates remained gaping after the snail was pulled away. Often the proboscis could be seen being withdrawn from between the scutal plates as the snail was removed. At Turn Rock all three species of Thais were found preying on Balanus cariosus as well as on Mytilus edulis, although both T. canaliculata and T. lamellosa appeared to prey primarily on the mussel. Thais emarginata, on the other hand, was found preying more often on barnacles than on mussels, and on both B. cariosus and B. glandula. At Kanaka Bay T. canaliculata and T. lamellosa were found preying on B. cariosus, and T. emarginata on B. cariosus and Chthamalus dalli.

Observations were made during high water at Turn Rock on August 9 and 10, using a glass-bottomed underwater viewer. Numerous Thais emarginata were seen scattered over the barnacle beds; it is not unlikely that many of these were feeding. Thais canaliculata were

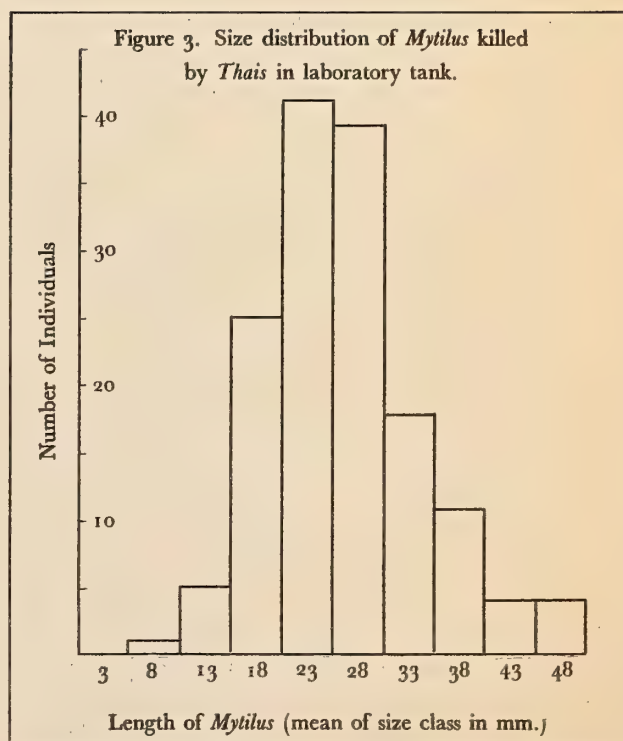
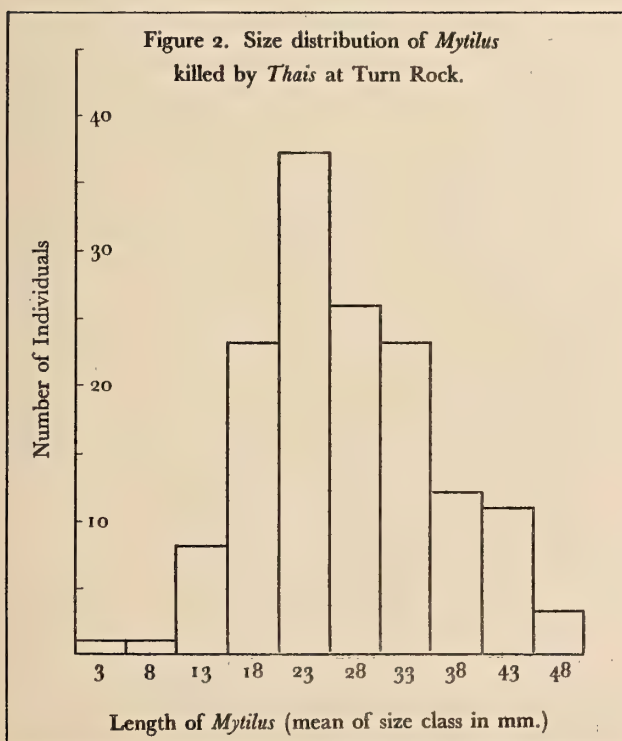
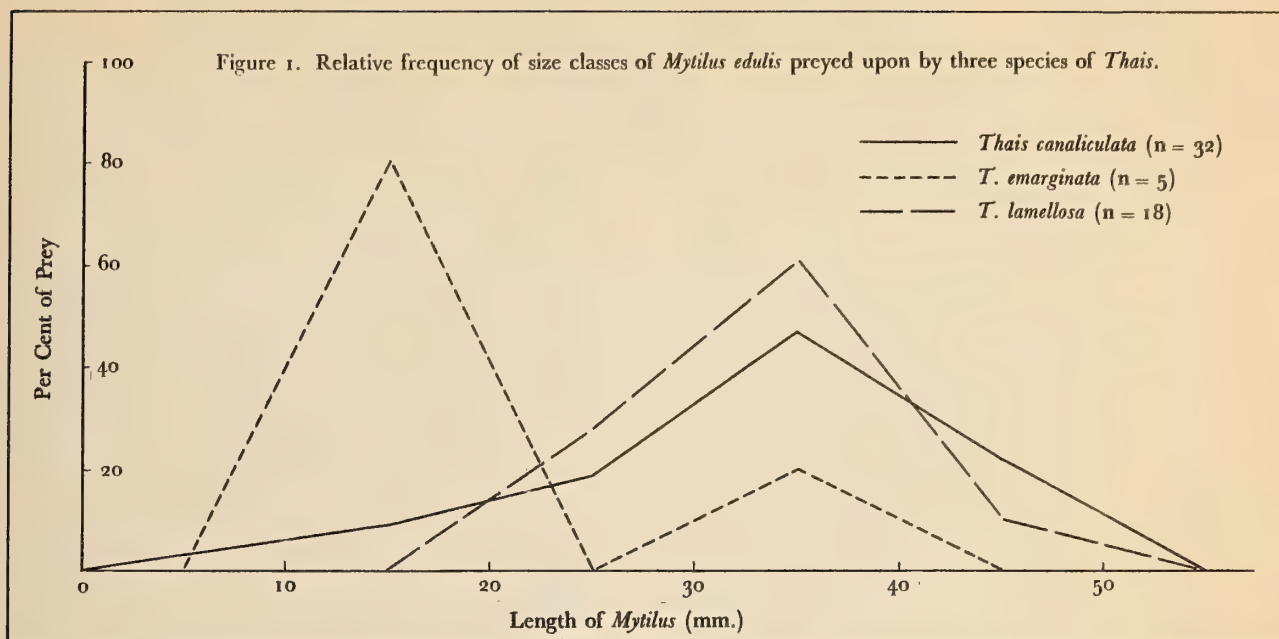
abundant on exposed, higher Mytilus beds where, during low water, they were not present. Since drilled Mytilus shells were common on the higher Mytilus beds, and Thais canaliculata could be found aggregated there in crevices during low water, it appears that on these more exposed mussel beds Thais canaliculata does most of its feeding during low water. In the lower beds, which remain moist during low water, it could be found feeding when exposed by the tide. Pisaster ochraceus could be seen during high water at the lower margin of the community; they did not move up onto the barnacle or mussel beds.

On August 13 counts were made of mussels, barnacles, and snails in eight 25 cm. square quadrats at Turn Rock. Three counts were taken below the zero tide level, just above the lower edge of the mussel bed; two were made in the center of the mussel bed, and three were made in the higher barnacle bed. At each level the sites of the separate counts were determined by tossing the quadrat marker. In each quadrat snails were identified and the length of their shells measured, and living mussels and barnacles were counted in situ; dead mussel shells were collected and taken to the laboratory for measurement and examination for holes drilled by Thais.

A total of 145 dead, drilled Mytilus shells was taken in the quadrat counts at Turn Rock, representing 24% of the total number of mussels in the quadrats. Size distribution of these drilled shells is shown in Plate 8, figure 2. The mean size of this sample was 27 ± 1 mm. This is significantly smaller (using the t-test; $P = .005$) than the mean of 31 ± 1 mm. for the total of Mytilus in the predation observation samples from the same area. It should be noted that the mean size of the Thais canaliculata

in the sample taken from the quadrat counts was 23 ± 1 mm. This is significantly smaller ($P = .005$) than the mean of 29 ± 1 mm. for those in the predation observation sample. Similarly, the mean size of Thais lamellosa from the quadrat counts, which was 37 ± 2 mm., is significantly smaller ($P = .005$) than the mean of 47 ± 2 mm. for those taken in the predation observation sample. These differences are due, undoubtedly, to a sampling bias made in the predation observations. Perhaps, then, the mean size of Mytilus from the predation observation sample is greater than that from the quadrat counts because of a positive correlation in size of prey and size of predator. To test this, correlation coefficients were calculated for the size of both species of snails and their Mytilus prey, but neither differed significantly from zero. Some other explanation seems likely, therefore. Since the dead mussels collected at Turn Rock were drilled at some unknown time in the past, the smaller mean for this sample may be due to presence in the sample of shells drilled when the population was much younger. On the other hand, the difference may reflect the inclusion in the sample of numerous mussels killed by T. emarginata, which we have seen appears to select smaller mussels than do the other two species. Only five Mytilus killed by Thais emarginata were included in the data from the predation observation sample. Additional evidence supporting the second suggestion will be developed below.

A collection of mussel and barnacle covered rocks, portions of the mussel mat, and representatives of all three species of snail predators was made at Turn Rock on August 2. The material was taken to the laboratory and placed in a glass-fronted outdoor tank supplied with running seawater. Thirty-four



.....

snails, including some of each species, were marked with numerals of red enamel. Subsequently, observations were made two or more times daily, and a notation was made when a snail appeared to be feeding. When a particular snail moved, after having been stationary on a particular mussel or barnacle during two or more consecutive observations, the mussel or barnacle was examined to determine whether it had been preyed upon by the snail. In addition, the aggregates of Mytilus in the tank were examined on August 6 and all dead shells removed.

Twenty days following removal of the original dead Mytilus from the tank, all drilled, dead Mytilus were again removed. They numbered 145. A histogram of their size distribution is shown in Plate 8, figure 3. It is similar to that for the 145 drilled shells taken in the Turn Rock quadrat counts (equal numbers being a coincidence). The mean size of drilled Mytilus from the laboratory tank was 26 ± 1 mm., which does not differ significantly from the mean of 27 ± 1 mm. from the quadrat counts. The mean from the laboratory tank differs significantly from that for the predation sample ($P = .005$), as does the mean from the quadrat counts (see above). Two explanations may be suggested for these results. On the one hand, it is possible that the small mean size of killed Mytilus from the laboratory tank indicates, that, inadvertently, the mussels brought to the laboratory were smaller on the average than those in the field population from which they were taken. On the other hand, the mean of the predation observation sample may be larger than that from the laboratory tank, as well as that from the quadrat counts, because it reflects little influence of small Mytilus killed by Thais emarginata. The similarity of size distribution of drilled Mytilus from quadrats and

tank can be taken to suggest that similar size classes were available in the tank and on Turn Rock. It would appear, for this reason, that the second suggestion is supported more strongly by the evidence.

In 24 observations of predation in the laboratory tank a record was kept of the length of time spent by marked predators on their prey. Eighteen of these fell in a 24 to 48 hour range. One snail remained on its prey 56 hours, and two almost 70 hours. Three persisted only four hours; these animals may have been interrupted before completion of the feeding process. Apparently the length of time usually required for a snail to complete drilling and feeding is on the order of one to two days. No differences in feeding time were detected for different species of predator, nor for different species of prey.

From the observations made in the laboratory tank, it is possible to calculate a very speculative, but nonetheless interesting, feeding rate of Thais canaliculata on Mytilus edulis. Of 28 feeding observations in which Mytilus was the prey, 22 involved T. canaliculata as predator. If it may be assumed from this that 80% of the 145 Mytilus killed during the 20-day period were preyed upon by T. canaliculata, we compute that 116 of the dead Mytilus were attacked by snails of this species. Present in the tank during the period were 43 individual T. canaliculata. On the basis of this, a feeding rate of 0.13 mussels/snail/day was computed. For comparison, Hanks (1957) found that Urosalpinx cinerea (Say) fed on 10 to 30 mm. long Mytilus edulis at the rate of 0.24 mussels/oyster-drill/week, or 0.034 per day. Connel (in press) reported that Thais lapillus (Linnaeus) fed on Balanus balanoides (Linnaeus) at Millport at the rate of 1.0 to 1.3 per day in the summer and 0.4 per day during the winter.

For a period of one week notations were made on prey specificity for the predators in the laboratory tank. Barnacles and mussels were present in approximately equal numbers. In 23 instances of predation by T. canaliculata, all but one were on Mytilus. In the field observations at Turn Rock, 32 instances of T. canaliculata preying on Mytilus were recorded, as compared to 23 instances on Balanus. In the latter survey, an effort was made to get both prey-predator combinations to obtain data for other purposes, so it is probable that the T. canaliculata-Balanus combination is high in this sample relative to its incidence in the field. At any rate, it definitely appears that T. canaliculata preferentially selects Mytilus over Balanus. Less data are available for the other two species of snails, but no tendency to select primarily mussels or barnacles was detected for either.

It was pointed out earlier that the mussel-barnacle community at Turn Rock is sharply delimited at its lower margin. It is in this area that the ranges of Thais canaliculata and T. lamellosa overlap. Furthermore, along the lower margin of the community were large numbers of Pisaster ochraceus; these were observed preying on both mussels and barnacles. It is suggested that the sharp lower boundary of the mussel and barnacle beds may be due to predation by seastars, coupled with heavy predation pressure from the muricid snails. Newcombe (1935) has made the same suggestion in relation to Mytilus edulis communities in the Bay of Fundy. There Thais lapillus (Linnaeus) was the snail predator. Newcombe included in his predator list two species of Arbacia plus Strongylocentrotus drohbachiensis (O. F. Muller). Although S. drohbachiensis is extremely common

on the bare rock bottom surrounding Turn Rock, nothing during the course of this study was observed to suggest that these organisms were preying on either mussels or barnacles. They were never seen in contact with the mussel-barnacle beds, at low or high tide. Newcombe's conclusion was based upon the fact that a portion of the dead Mytilus shells examined by him were cracked along the edges, which he interpreted as evidence of predation by sea urchins. Weese (1926), studying gut contents of S. drohbachiensis in Puget Sound (Washington Sound?) found that the urchins fed mainly on plant detritus. It is clear that the available evidence does not warrant the classification of S. drohbachiensis as an important predator in mussel-barnacle communities.

It appears from this pilot study that predation by Thais and Pisaster may play an important role in affecting population numbers of Mytilus in mussel-barnacle communities of the Washington Sound rocky intertidal area. Although no data are available to indicate the quantitative impact of seastar predation on the mussel population, certainly the muricid snails must take an appreciable proportion of the Mytilus population each year. Twenty-eight per cent of the total mussel sample from the quadrats at Turn Rock were dead; of these, 86% had been killed by snails. The effect of predation in reducing Mytilus numbers, relative to that of other factors (e.g., variations in reproductive success, competition for space, etc.), is unknown. Nevertheless, it is clear that predation must be important in affecting population turnover of the mussels, and it may even affect spatial limits of the community.

There exists here an unusually promising opportunity for critical field analysis of the effect of predation on natural populations, by both sample survey and experimental

approaches. This could readily be developed into an investigation of material exchange and energy flow in the mussel-barnacle community or ecosystem.

SUMMARY

1. Major predators on mussels and barnacles at two locations in Washington Sound were Thais canaliculata, T. lamellosa, T. emarginata, and Pisaster ochraceus.
2. All three species of snails feed on both mussels and barnacles, but Thais canaliculata appears to feed preferentially on mussels.
3. Thais canaliculata and Thais lamellosa select Mytilus of the same size class as prey, while T. emarginata appears to select smaller mussels.
4. Predation by Pisaster is confined to the lower margin of the community, where also predation pressure from snails is probably the heaviest.
5. 86% of dead Mytilus collected in the field had been killed by snails.
6. It is concluded that predation is important in affecting turnover in the mussel population, and may limit the distribution of the community at its lower boundary.

ACKNOWLEDGEMENTS

The author wishes to thank Professor Frank A. Pitelka for his critical reading of the manuscript, Dr. William Taylor for his criticisms and suggestions regarding the statistics used, and Dr. Dixy Lee Ray for her helpful comment and cooperation during the course of the field work.

LITERATURE CITED

- Connell, J.H.
In press. Studies of some factors affecting the recruitment and mortality of natural populations of intertidal barnacles. Univ. Wash. Press. Proceedings of the Friday Harbor Symposium on Marine Boring and Fouling Organisms.
- Hanks, J.E.
1957. The rate of feeding of the common oyster-drill, Urosalpinx cinerea (Say), at controlled water temperatures. Biol. Bull., vol. 112, pp. 330-335.
- Henry, D.P.
1940. The Cirripedia of Puget Sound with a key to the species. Univ. Wash. Pub. Oceanography, vol. 4, 48 pp.
- Jensen, A.S.
1951. Do the Naticidae drill by chemical or by mechanical means? Vidensk. Medd. Dansk. naturh. Foren., vol. 113, pp. 251-261.
- Kruskal, W.H., and W.A. Wallis.
1952. Use of ranks in one-criterion variance analysis. J. Amer. Statist. Ass., vol. 47, pp. 583-621.
- Newcombe, C.L.
1935. A study of the community relationship of the sea mussel, Mytilus edulis L. Ecology, vol. 16, pp. 234-243.
- Siegel, Sidney.
1956. Nonparametric statistics for the behavioral sciences. New York: McGraw-Hill Book Co., Inc. xvii + 312 pp. Pp. 184-194.
- Weese, A.O.
1926. Food and digestive processes of Strongylocentrotus drohbachensis. Publ. Puget Sound Biol. Sta., vol. 5, pp. 165-179.

MOLLUSKS FROM MOUNTAIN LAKE, SAN FRANCISCO, CALIFORNIA

by

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Mountain Lake (Laguna del Presidio) is a natural body of water located along the south side of the Presidio, a military reservation adjacent to Mountain Lake Park. The lake lies between Eleventh and Funston Avenues if projected, at an altitude of about 38 meters (125 feet). It is elongately triangular in shape and covers an area of approximately 21,000 square meters (24, 150 square yards). A bronze plaque on a boulder on the south shore of the lake records the fact that the early Spanish explorer, Juan Bautista de Anza, camped there March 27, 1776.

Early maps of this area indicate that Mountain Lake formerly was a little more extensive than at the present time. On "Bancroft's Official Guide Map of City and County of San Francisco", 1889, the south end of the lake is indicated as extending east approximately to Eighth Avenue if projected. Fortunately the lake has escaped major changes during the growth of the city. In the early days of San Francisco this lake was used, at least in part, as a source of water supply by the Mountain Lake Water Company which was organized in 1851 (Samuel Colville's San Francisco Directory for 1856, p. 307).

Acknowledgement is due Dr. G. D. Hanna, Curator, Department of Geology, California Academy of Sciences, and Miss V. J. Sexton, Librarian, at the same institution, and Messrs. J. Schlocker and M. G. Bonilla, Geologists, U. S. Geological Survey, Menlo Park, California, all of whom furnished information pertinent to this study.

J. G. Cooper was interested in the molluscan fauna of the lake and in 1870 he wrote, "At Mountain Lake, near San Francisco, a sheet of permanent and clear water, shallow but cool at all seasons, we find only seven forms of univalves and three bivalves, which is even more than I have heard of in any other so limited space. At Santa Cruz, a year's search in two perpetual streams furnished only five univalves and two bivalves, four of the seven distinct from those of Mountain Lake."

Stearns (1881, p. 106) remarked upon specimens of Physa gabbii with peculiarly distorted outer lips. This deformation he believed was due to the effect of the wind blowing the snails across the lake forcing them against plants and other objects floating upon and occurring around the border of the lake.

It seems desirable at this time to bring together the scattered records of mollusks in this lake. A perusal of the literature and a search in the collections of the California Academy of Sciences has yielded the names of 19 described forms of which three have this lake as their type locality. In contrast to this number, Ingram and Kenyon (1947) recorded from Stow Lake (an artificial body of water) in San Francisco, only five species of gastropods and two pelecypods (one of these the genus only, the species unidentified).

We have not attempted to arrange these names in conformity with modern synonymy, believing that a simple list of the names together

with an indication of the authority for the locality record fulfills the purpose of the present paper. However, we have assigned the species to the genera currently used in taxonomy. A careful study of specimens from this lake undoubtedly would greatly reduce the number of taxonomic units listed here. There may exist records of additional species from Mountain Lake which have escaped our notice but the following ones have been assembled from published records or from authentic collections from that body of water.

PELECYPODA

- Anodonta nuttalliana nuttalliana Lea (Ingram, 1948, p. 79).
Anodonta wahlamatensis Lea (Ingram, 1948, p. 83).
Pisidium occidentalis Newcomb (Calif. Acad. Sci. Coll. H. Hemphill, collector).

GASTROPODA

- Gyraulus (Menetus) opercularis (Gould) (Tryon, 1863, p. 150 [as Planorbis "orercularis"]; F. C. Baker, 1945, p. 186, pl. 38, figs. 1, 2, 4-10; pl. 120, figs. 1-10 [as Menetus opercularis]).
Gyraulus vermicularis (Gould) (Tryon, 1863, p. 150 [as Planorbis vermicularis]; F. C. Baker, 1945, p. 74, [as Gyraulus vermicularis]).
Helisoma ammon (Gould) (F. C. Baker, 1945, pl. 95, figs. 1-5).
Helisoma hemphilli F. C. Baker and Henderson (type locality) (1934, p. 141).
Helisoma occidentalis Cooper var. (Stearns, 1881, p. 101 [as "P. var. occidentalis, Cp."]).

- Helisoma trivolvis (Say) (Tryon, 1863, p. 150 [as Planorbis trivolvis]).
Lymnaea fragilis (Linnaeus) (Tryon, 1863, p. 149 [as Limnaea fragilis]).
Lymnaea palustris (Müller) (Tryon, 1865, p. 251 [as Limnophysa palustris]).
Lymnaea reflexa Say (Tryon, 1863, p. 149 [as Limnaea reflexa]).
Lymnaea rowelli Tryon (F. C. Baker, 1911, p. 363, [as Galba proxima rowellii]).
Lymnaea traskii Tryon (type locality) (Tryon, 1863, p. 149, pl. 1, fig. 13 [as Limnaea traskii]; Carpenter, 1864, p. 674, and 1872, p. 160 [as Limnaea (Limnophysa) traskii]; Tryon, 1865, p. 254, [as Limnophysa traskii]; W. G. Binney, 1865, p. 60, fig. 94 [as Limnaea traskii]; Cooper, 1867, p. 18 [as Limnophysa traskii]; F. C. Baker, 1911, p. 39 [as Galba traskii]).
Lymnaea umbrosa Say (Tryon, 1863, p. 149 [as Limnaea umbrosa]; Tryon, 1865, p. 250 [as Limnophysa umbrosa]).
Physa gabii Tryon (type locality) (Tryon, 1863, p. 149, pl. 1, fig. 14; Carpenter, 1864, p. 674, and 1872, p. 160 [as Physa (Physa) gabii]; W. G. Binney, 1865, p. 77, fig. 128, [as Physa gabii]; Cooper, 1867, p. 19 [as Physa gabii]).
Physa gyrina Say (Tryon, 1863, p. 149).
Tropicorbis gracilentus (Gould) (Tryon, 1863, p. 101 [as Planorbis gracilentus]).
Viviparus japonicus iwakawa Pilsbry (Hama, 1939, p. 311 [as Vivipara malleata Reeve]).

LITERATURE CITED.

- Baker, F. C.
 1911. The Lymnaeidae of North and Middle America, Recent and Fossil. Chicago Acad. Sci., Spec. Publ. No. 3, pp. I-XVI, 1-539, figs. 1-51 in text, pls. 1-58, February 15.
 1945. The Molluscan Family Planorbidae. (Univ. Illinois Press: Urbana), pp. I-XXXVI, 1-530, pls. 1-141. (Collation, Revision, and Additions by H. J. Van Cleave, pp. XVII-XXIV.) (For a more complete index see Baker, H. B., Nautilus, Vol. 59, No. 4, pp. 127-141, April, 1946.)
- Baker, F. C., and Henderson, J. (in F. C. Baker).
 1934. (In) Two New Races and a New Species of Helisoma from California. Nautilus, Vol. 47, No. 4, pp. 141-142, April (issued May 4).
- Binney, W. G.
 1865. Land and Fresh Water Shells of North America. Part II. Smithsonian Miscell. Coll., No. 143, pp. 1-161, figs. 1-261 in text, Sept.
- Bolten, H. E.
 1930. Anza's California Expeditions. (Univ. California Press: Berkeley), Vols. 1-5. (Concerning Mountain Lake see especially Vol. 1, p. 391 and upper illustration opposite p. 384; Vol. 3, pp. 126, 127, 354; Vol. 4, pp. 329-330, 341, and map opposite p. 342.)
- Carpenter, P. P.
 1864. Supplementary Report on the present state of our knowledge with regard to the Mollusca of the West Coast of North America. Rept. Brit. Assoc. Adv. Sci., for 1863, pp. 517-686, August, 1864. Reprint in Smithsonian Miscell. Coll., No. 252, pp. 1-172, 1872.
- Cooper, J. G.
 1867. Geographical Catalogue of the Mollusca found west of the Rocky Mountains, between Latitudes 33° and 49° north. Geol. Surv., California. (Towne and Bacon, printers, San Francisco), pp. 1-40.
 1870. The West-Coast Fresh-Water Univalves, No. 1. Proc. Calif. Acad. Sci., Vol. 4, pp. 92-100, February.
 1890. Fresh-water Mollusca of San Francisco County. Zoe, Vol. 1, pp. 196-197.
- Hanna, G. D.
 1939. Exotic Mollusca in California. Bull. Dept. Agric., State of California, Vol. 28, No. 5, pp. 298-321, figs. 1 and 2 in text, pls. A-D, May.
- Hannibal, H.
 1911. Shells of Lakes and Streams. (In Keep, J., West Coast Shells: Whitaker and Ray-Wiggin Co., San Francisco), pp. 299-318, figs. 288-300 in text, pls. 1-3.
- Hoover, M. B.
 1937. Historic Spots in California. (Stanford University Press, Stanford University), pp. VII-VIII (Preface), 1-718. (With an Introduction by R. G. Cleland, pp. XI-XXIII.) (Concerning Mountain Lake see p. 321.)
- Ingram, W. W.
 1948. The larger Freshwater Clams of California, Oregon, and Washington. Jour. Entomol. and Zool., Vol. 40, No. 4, pp. 72-92, two figs in text, pls. 1-2, December.
- Ingram, W. M., and Kenyon, K. W.
 1947. Anodonta and associated mollusks from Stow Lake, Golden Gate Park, San Francisco, California. Nautilus, Vol. 61, No. 2, pp. 51-53, October (issued December 18).

Stearns, R. E. C.

1881. Observations on Planorbis.
Proc. Acad. Nat. Sci. Phila-
delphia, Vol. 33, pp. 92-110,
figs. 1-27 in text, June 21.
(See especially pp. 101, 106.)

Tryon, G. W., Jr.

1863. Descriptions of New Spe-
cies of Fresh Water Mollusca,
'belonging to the Families
Amnicolidae, Valvatidae, and
Limnaeidae; inhabiting Califor-
nia. Proc. Acad. Nat. Sci.
Philadelphia, Vol. 15, No. 3,

pp. 147-150, May. (Acknow-
ledgement of receipt of pub-
lication by Smithsonian Insti-
tution, July 13.)

1865. Descriptions of New Spe-
cies of North American Lim-
naeidae. Amer. Jour. Conch.,
Vol. 1, No. 3, pp. 223-231,
pls. 22-23, July 1.

1865. Catalogue of the Species
of Limnaea inhabiting the
United States. Amer. Jour.
Conch., Vol. 1, No. 3, pp.
247-258, July 1.

KEY TO THE CONE SHELLS OF WESTERN TROPICAL AMERICA

by

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1. Shell with coronated spire.
Granulated on shoulder of the
body whorl 2
- Shell with smooth spire 8
2. Shell weakly coronated. 3
- Shell strongly coronated. 4
3. Shell purple on anterior tip
of aperture. Length 22 mm.
- . 1. Conus musicus nux Broderip .
- Shell with anterior tip not
purple. Length 28 mm.
- . . 2. Conus gladiator Broderip .
4. Shell brown with light central
transverse band on body whorl. . 5
- Shell cream-colored, with
transverse rows of dark dots . . 6
- Shell pink or flesh-colored . . 7
5. Shell with white spots around
periphery and white aperture.
Length 60 mm.
- 3. Conus brunneus Wood.
- Shell without white spots
around periphery and with purple
aperture. Length 40 mm.
4. Conus brunneus diadema Sowerby.
6. Shell with two irregular trans-
verse bands of brown on body
whorl. Many rows of small
dots. Length 50 mm. . . 5. Conus
bartschi Hanna & Strong.
- Shell without brown trans-
verse bands. Few rows of
large dots present. Length
30 mm.
- . 6. Conus tiaratus Sowerby.
7. Shell deep pink with heavy,
widely separated longitu-
dinal brown stripes. Length
70 mm.
7. Conus princeps Linnaeus .
- Shell light pink with many
close, longitudinal dark
stripes. Length 60 mm.
- 8. Conus prin-
ceps lineolatus Valenciennes.
- Shell light pink, without
markings. Length 60 mm.
- 9. Conus
princeps apogrammatus Dall.
8. Shell with long, produced
spire 9
- Shell with spire not
greatly produced. 11

9. Shell with narrow body whorl. 10
- Shell with body whorl of medium width. Spire nearly as long as body whorl. Color white with three indistinct transverse rows of blotches. Length 36 mm. 10. Conus arcuatus Broderip & Sowerby.
10. Shell with many transverse rows of black dots. Length 20 mm. 11. Conus tornatus Sowerby.
- Shell with a few transverse rows of dark dots and blotches. Ground color light yellow. Spire greatly produced and turreted. Length 50 mm. 12. Conus scalaris Valenciennes.
11. Shell with rounded shoulder on body whorl at base of spire. 12
- Shell with sharp shoulder at base of spire. 21
12. Shell without markings. 13
- Shell with markings . . . 14
13. Shell flesh color, with greatly reduced spire. Length 72 mm. 13. Conus patricius Hinds.
- Shell white, with slightly produced spire. Juvenile yellow, with several transverse white bands. Length 150 mm. 14. Conus fergusonii Sowerby.
14. Shell with three wide orange transverse bands crossed by black longitudinal lines. Remainder of body whorl articulated with white triangles. Length 50 mm. 15. Conus dalli Stearns.
- Shell without wide orange bands 15
15. Shell with web-like network making transverse rows of white spots across body whorl. Aperture purple. Length 50 mm. 16. Conus lucidus Wood.
- Shell without network of lines 16
16. Shell purple in color. Length 56 mm. 17. Conus purpurascens Sowerby.
- Shell not purple. 17
17. Shell with transverse rows of small black dots . . . 18
- Shell without rows of small black dots. 19
18. Shell pink. Spiral white band blotched with brown across body whorl. Length 40 mm. 18. Conus vittatus Bruguière.
- Shell not pink. Ground color light, with many even spiral rows of black dots. Aperture purple. Length 42 mm. 19. Conus ximenes Gray.
- Shell like that of C. ximenes but smaller and with white aperture. Length 38 mm. 20. Conus ximenes mahogani Reeve.
19. Shell pink or flesh color, with a few brown blotches on body whorl. Length 60 mm. . 21. Conus virgatus Reeve.
- Shell not pink. Large black spots or blotches on body whorl. 20
20. Shell with black spots in even rows. Length 40 mm. . . 22. Conus ebraeus Linnaeus.
- Shell with black longitudinal blotches nearly covering shell. Body whorl with white spiral band around center. Length 38 mm. . . . 23. Conus chaldaeus Röding.
21. Shell tinged with orange at anterior end of aperture. Length 36 mm. 24. Conus orion Broderip.
- Shell not tinged with orange in aperture. 22
22. Shell with spiral rows of small black dots. 23
- Shell without rows of small black dots. 24

23. Shell with white aperture.
Length 30 mm.
25. Conus regularis Sowerby.
-. Shell with purple aperture.
Length 30 mm.
26. Conus perplexus Sowerby.
24. Shell with transverse rows
of square spots 25
-. Shell without transverse
rows of square spots, but
blotched with brown 26
25. Shell white with brown
spots in spiral rows. Aper-
ture white. Length 54 mm. .

- . 27. Conus gradatus Wood.
-. Shell flesh color with
spiral rows of orange spots.
Length 35 mm.
28. Conus tessulatus Born.
26. Shell heavy and wide at
shoulder of body whorl.
Spire short. Length 68 mm. .
. 29. Conus archon Broderip.
-. Shell thin with slightly
produced spire. Body whorl
a little concave below
shoulder. Length 65 mm. . .
30. Conus recurvus Broderip.

ACMAEA PARADIGITALIS SP. NOV. (ACMAEIDAE, GASTROPODA)

by

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During the course of several years of collecting Acmaea from the intertidal region in the vicinity of San Francisco, a limpet was continually found which morphologically could not be included in any known species. Further studies have shown that the animal's ecology and behavior patterns are distinctly different from those of its most probable closest relative, Acmaea digitalis Eschscholtz. Because the new species is frequently found with A. digitalis, which it resembles in a general way, it is proposed to name the new limpet Acmaea paradigitalis.

DESCRIPTION.

Acmaea (Collisella) paradigitalis, new species.

SHELL: Small, conical (Plate 9, figs. 1, 1a); length 16 mm., width 12 mm., height $5\frac{1}{2}$ mm.; sculpturing absent; aperture subovoidal, egg

shaped, with anterior end narrower than posterior; margin entire; lateral and posterior surfaces convex outward, anterior surface very slightly convex outward; apex lies 31% of shell-length from anterior end; external surface tessellated with brown and white producing an overall gray color, the pattern being interrupted by irregularly spaced brown and white lines radiating from the apex and most prominent at the posterior end of shell; apex slightly eroded so that inner nacreous layer is visible; internal color a bluish white throughout although external markings are visible through the shell; margin without nacre and irregularly marked by the ends of the radial lines on the external surface.

ANIMAL: Completely white overall, with the flesh of the foot slightly translucent.

RADULA: (Plate 10, fig. 3) individual links approximately

square, each bearing two pairs of brown lateral teeth, the more medial pair being monocuspid and the more lateral pair bicuspid; marginal teeth in the form of a pair of tiny uncini near the junctions of adjacent radular links; central teeth are lacking.

TYPE LOCALITY: Western surface of the breakwater at the Berkeley Yacht Harbor, Berkeley, Alameda County, California, appr. 32°50' N., 122°19' W. Holotype collected on November 6, 1953.

PARATYPES: Five specimens, collected with the holotype and differing from it primarily in size and in degree of erosion, have been designated as paratypes. The differences between these and the holotype are listed below.

PARATYPE I: Size, 15 mm., 12 mm., 5½ mm.; apex of shell located 27% of shell length from anterior end; external radial lines less pronounced.

PARATYPE II: Size, 15.2 mm., 12 mm., 5½ mm.; apex 25% of shell length from anterior end; anterior surface slightly concave; external radial lines more prominent, particularly in lower half of shell.

PARATYPE III: Size, 14.8 mm., 11 mm., 6 mm.; apex 34% of shell length from anterior end; erosion severe, periostracum absent; lower half of shell with alternating radial lines of brown and gray; anterior end more narrow; lateral surfaces plane, anterior surface concave.

PARATYPE IV: Size, 13 mm., 10 mm., 5 mm.; apex 31% of shell length from anterior end; erosion severe, periostracum absent; apex gray, middle third of shell brown, lower third with alternating brown and gray radial lines; lateral surfaces plane,

anterior concave.

PARATYPE V: Size, 14.5 mm., 11 mm., 4.8 mm.; apex 28% of shell length from anterior end; severe erosion, without periostracum; apical half of shell gray, lower half with dark brown triangular areas alternating with gray which is continuous with that of upper half of shell; anterior surface slightly concave; internal color pale bluish white with a very pale brown ring internal to shell muscle scar.

DISTRIBUTION OF TYPES: The Holotype and Paratypes have been deposited in the U. S. National Museum. Holotype (No. 611,301); Paratypes (No. 611,302). A representative set of the hypotypes shown on Plate 9 will be deposited in the California Academy of Sciences, San Francisco, California, and in the San Diego Museum of Natural History. An additional series of hypotypes will be deposited in the British Museum (Natural History), London.

DISCUSSION.

The limpet has been collected by the author from Vancouver, B. C., south to northern Baja California. As can be seen from Plate 9, there is considerable geographic variation within the species. In northern waters the interior is more consistently a clear bluish-white, while in Southern California it is frequently suffused with brown. Exceptions are occasionally met in which there may be scattered spots of brown, but typically a massive brown spot at the apex is absent. This feature is an aid in identifying since the apex is frequently eroded and shows a white tip rather



Fig. 1



Fig. 1a



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6

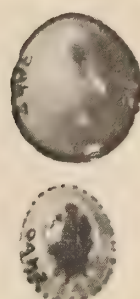


Fig. 7



Fig. 8



Fig. 9



Fig. 2a



Fig. 3a



Fig. 4a



Fig. 5a



Fig. 6a



Fig. 7a

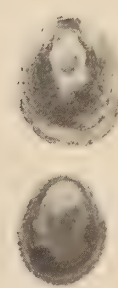


Fig. 8a

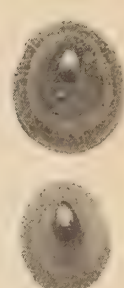


Fig. 9a

Acmaea paradigitalis, spec. nov., from various localities on the West Coast of North America

Figs. 1, 1a: The holotype from Berkeley, California. Figs. 2, 2a: Anacortes, Washington. Figs. 3, 3a: Mukkaw Bay, Washington. Figs. 4, 4a: Tacoma, Washington. Figs. 5, 5a: Port Orford, Oregon. Figs. 6, 6a: Pacific Grove, California. Figs. 7, 7a: Santa Rosa Island, California. Figs. 8, 8a: Corona del Mar, California.

Figs. 9, 9a: 40 mi. N. of Ensenada, Baja California.

Note: Figures 1 to 9 - View of Aperture; Figures 1a to 9a - Apical View.

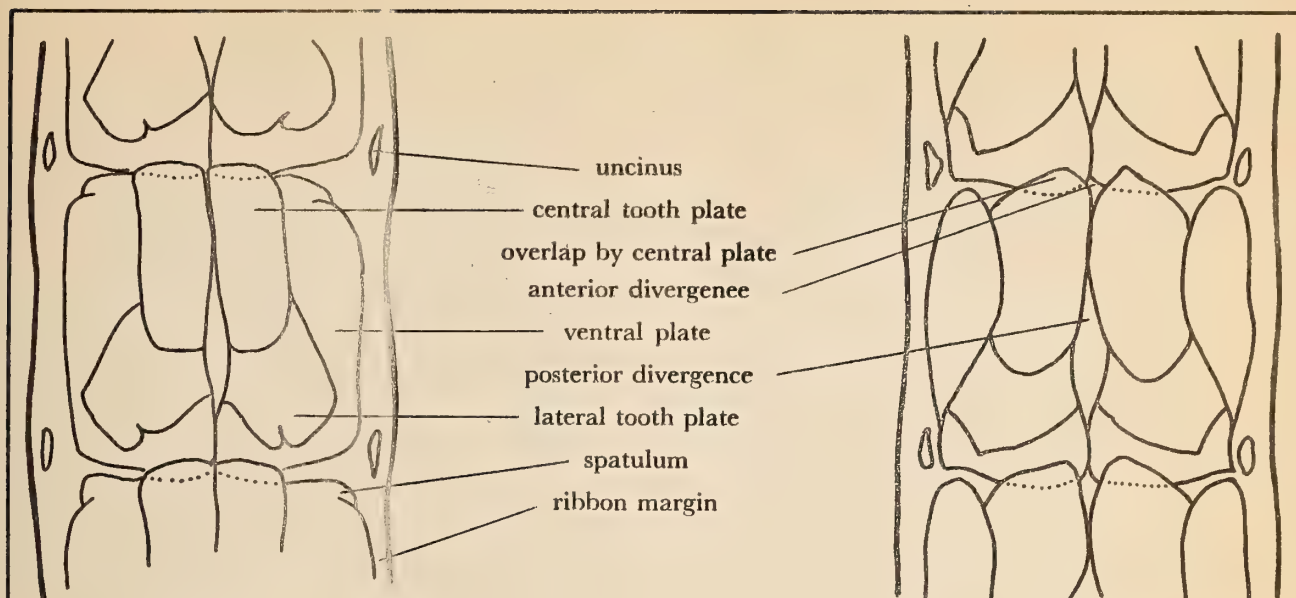


Figure 1

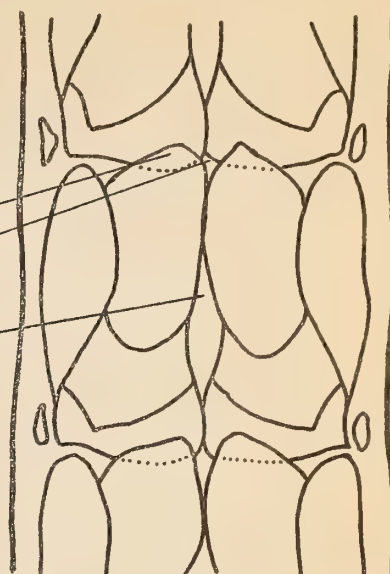


Figure 2

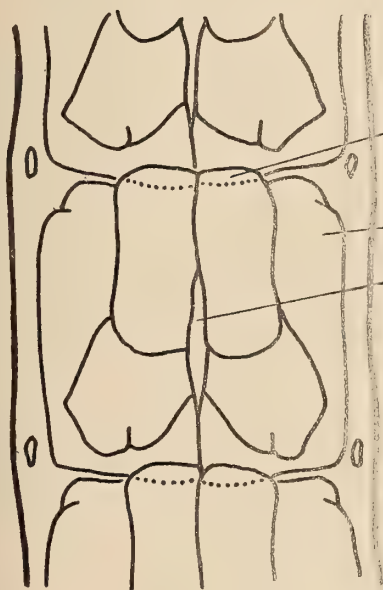


Figure 3

overlap by central plate
overlap by spatulum
shoulder
posterior divergence

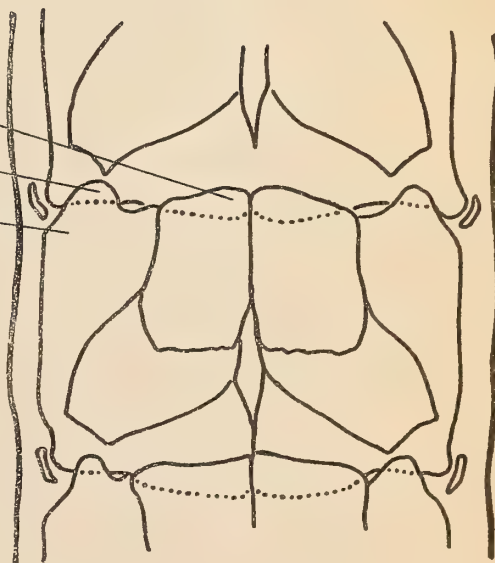


Figure 4

Radular ribbons of *Acmaea*.

Figure 1. General features of subgenus *Collisella*. Figure 2. *Acmaea digitalis*,
Figure 3. *Acmaea paradigitalis*. Figure 4. *Acmaea pelta*.



than the brown one of most of the other West Coast *Acmaeas*. North of Point Conception the shells are more narrow anteriorly and show little tendency to be inflated, that is, markedly convex outward. In general, the size increases conspicuously south of Point Conception. A total of 205 shells chosen at random was measured for length. The mean of 72 from the Puget Sound area was 10.9 mm.; of 73 from Oregon and California north of Point Conception, 12.0 mm.; of 60 south of Point Conception to the northern coast of Baja California, 15.4 mm. The largest shell collected is 22 mm. long, 18 mm. wide, and 9 mm. high. The apex is usually within the anterior one-third of the shell. The aperture is subovoidal, broadly rounded posteriorly; the anterior end is slightly more narrow. The posterior slope is convex; the anterior slope is plane. The internal color is bluish-white, typically without a massive brown spot at the apex, although small scattered spots of brown may be present. The interior margin is dark or with dark spots. The external color is variable, but frequently olive drab with a finely tessellated pattern in white or gray. If the apex is eroded, a white spot is conspicuous externally at this point. The shell is never ribbed and the aperture is entire. The foot is white above and below, usually without a yellowish tinge.

The differences which separate the new species most distinctly from *Acmaea digitalis* are two; the invariable absence of ribbing, and the bluish-white interior which

nearly always lacks the brown owl-shaped apical spot which characterizes *A. digitalis*. In all interior views of *A. paradigitalis* (Plate 9, figures 1 to 9), the individual shells have been arranged with the lightest shell from each sample at the top and the darkest shell at the bottom. Small specimens of *A. pelta* Eschscholtz may be confused with the new species.

However, *A. pelta* is frequently ribbed and bears an internal postapical spot. All of its exterior surfaces are plane and the apex is usually subcentral.

RADULA. The radulae of the three species were examined for consistent differences among them, the numbers used being 180 for *Acmaea paradigitalis*, 145 for *A. digitalis*, and 134 for *A. pelta*. These were prepared by dissolving the animal with 10% NaOH to obtain the radula. After removing the teeth with a camel's hair brush, the ribbons were stained with acetocarmine, dehydrated rapidly in alcohol and mounted in euparal. This treatment exposes the basal plates of the radula. In *Acmaea* these bear two pairs of lateral teeth, the more lateral pair being bicuspid. In the subgenus *Collisella*, marginal teeth are present in the form of small uncini. The features decided upon for analysis were the following: the length/width ratio (>1 , 0, <1); the presence of overlap by the central tooth plates of the segment adjacent to it (+, 0, -); the presence of a lateral shoulder on the ventral non-tooth bearing plates (+, -); the degree of divergence both anterior and posterior of the central tooth plates (anterior, posterior, anterior-posterior, and parallel); and

.....

finally, the overlap of the adjacent segment by the spatulum (Plate 10, figures 1 to 4). These features were recorded for each radula at the end where the plate-bearing ribbon flares out into an oval form. This was necessary since the plate pattern alters along the length of the ribbon. These data were converted to percentages and plotted as shown in Plates 11 and 12, figures 1 to 5.

The length/width ratio is shown in Plate 11, figure 1. The absolute stability of this character in the Acmaea pelta radula is immediately evident. A. paradigitalis is also relatively stable with minor shifting south of Point Conception (34° N. latitude). A. digitalis is the most variable, and the dimensions shift strongly in the southern latitudes.

The presence of shoulder is plotted in figure 2, Plate 11. This character is remarkably stable in both Acmaea pelta, which has it, and in A. digitalis, where it is absent. It is interesting to note that the character shifts strongly in A. paradigitalis north and south of Point Conception.

In figure 3, Plate 12, is plotted the overlap of the central tooth plate. In the southern waters Acmaea pelta is constant with only a minor shift in the northern collections. The other species are quite variable but the northern collections of A. digitalis and A. paradigitalis resemble each other, and this similarity also prevails in the southern collections.

The spatulum overlap, figure 4, Plate 12, shows again the near constancy of Acmaea pelta and the greater variabil-

ity of A. paradigitalis and A. digitalis, both of which tend to lack this character, making for a more loosely formed radular ribbon.

Finally, figure 5, Plate 12, shows the amount of divergence of the central plates. Acmaea digitalis shows a strong tendency for both anterior and posterior divergences; A. pelta has about equal numbers of individuals with posterior divergence and with parallel plates; A. paradigitalis south of 34 degrees is strongly parallel but in northern areas is less constant.

Thus the radula of Acmaea paradigitalis resembles that of A. pelta only in the length/width ratio. It resembles the radula of A. digitalis in the degree of spatulum overlap and degree of central plate overlap.

On the basis of the radula it seems that Acmaea paradigitalis is intermediate between the other two species. Indeed it has been suggested to be a hybrid between them (Grant, 1937). This is unlikely since A. paradigitalis in some areas is as abundant as A. digitalis and far more so than A. pelta. In other areas A. paradigitalis exists without one or the other of the supposed parental species being present. For example, at Alki Point in Seattle, Washington, A. digitalis was not found but both of the other species were plentiful; this also obtained in the Tacoma Narrows. Similarly in Tomales Bay, California, A. pelta occurs infrequently but the other two species are reasonably plentiful. Of course, the ease with which the planktonic larvae may be disseminated may partially negate these separate distributions, but it is highly unlikely

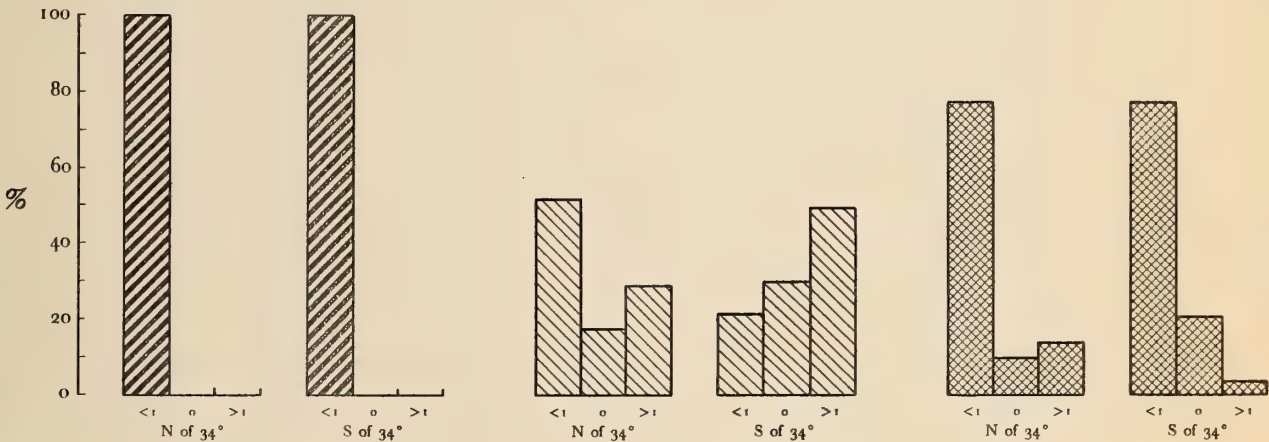


Fig. 1. Plot of radular length/width ratios

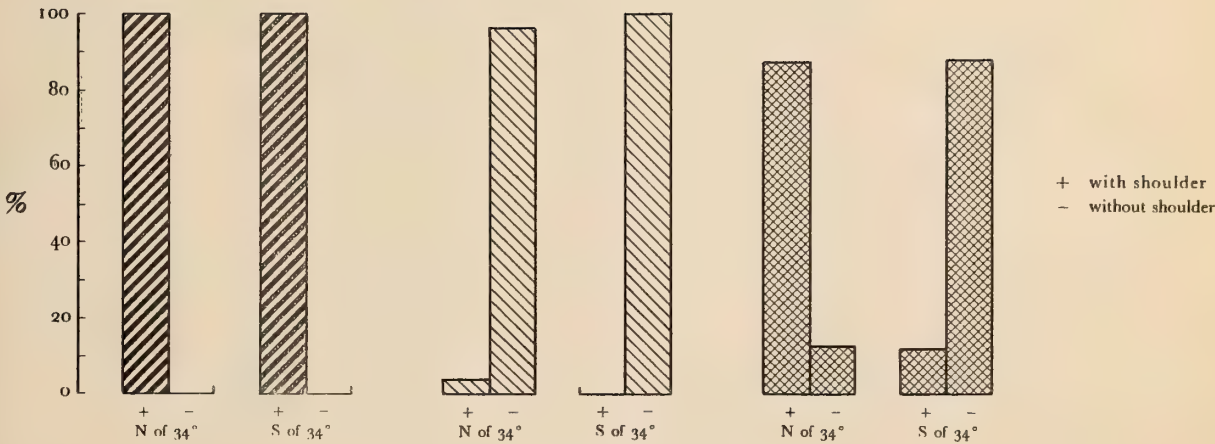


Fig. 2. Percentage of radulae with shoulder

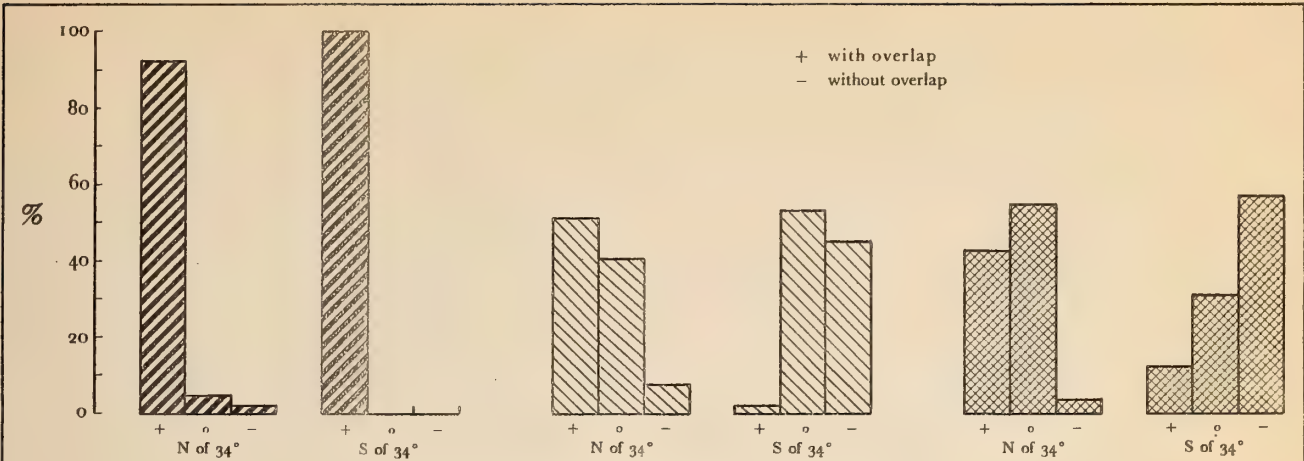


Fig. 3. Percentage showing central plate overlap

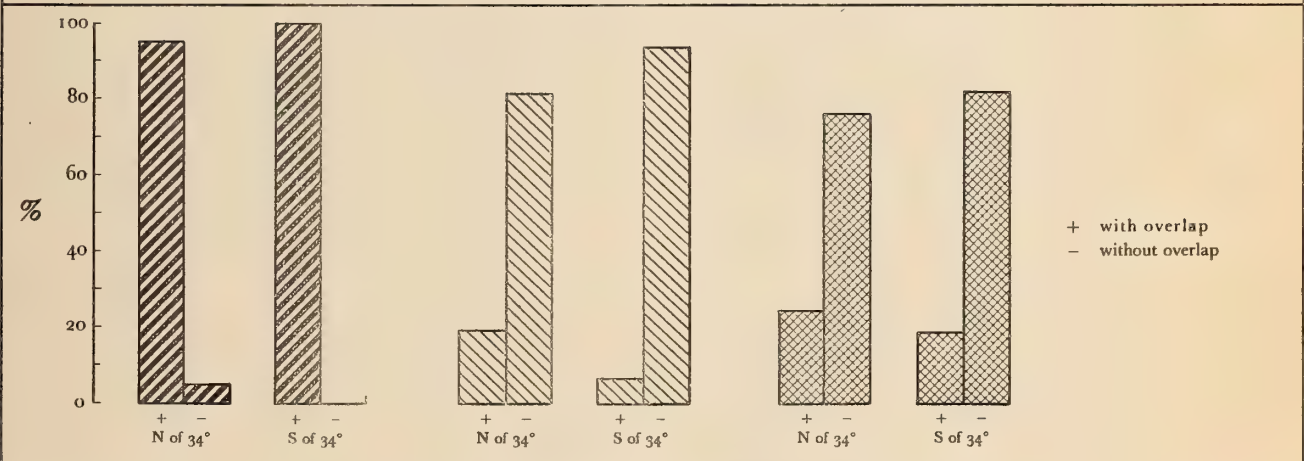


Fig. 4. Radulae showing spatulum overlap

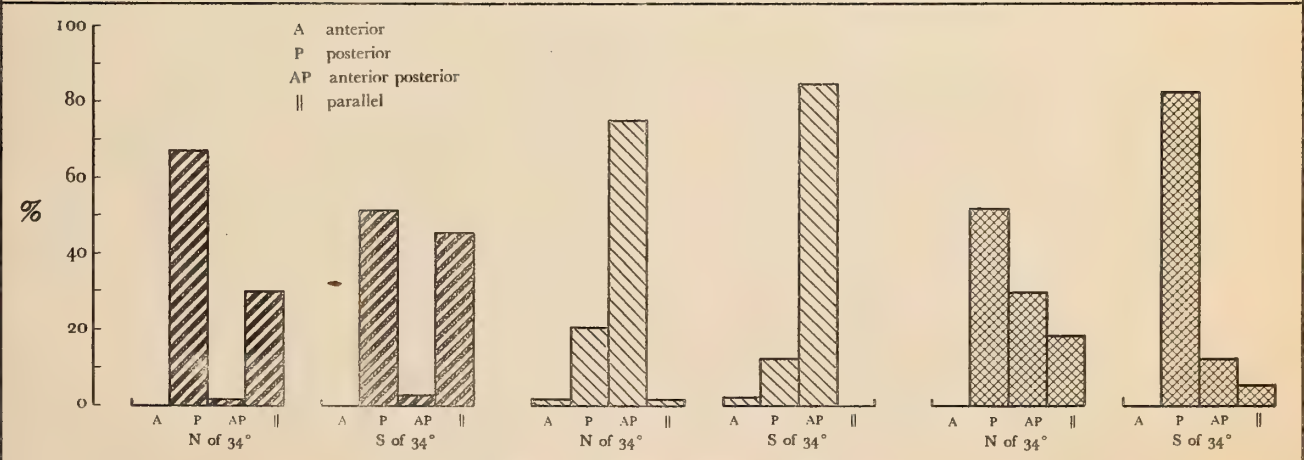


Fig. 5. Plot showing divergence patterns of central plate

that a hybrid animal should ever be as abundant as either parent or more abundant than one parent.

ECOLOGY. Ecologically Acmaea paradigitalis is distinctive, being most abundant in upper zone 2 of Ricketts and Calvin where there is considerable splash and some submergence. At this level it competes with A. digitalis for space but not with A. pelta which is found lower in the intertidal. A. digitalis extends much farther up into zone 1 and can be considered a splash zone animal. Furthermore, A. digitalis will not tolerate continuous submergence and thus is rarely found in a small tide pool. A. paradigitalis, however, together with A. scabra, is frequently found in just such a continuously submerged position.

Further behavior differences are being studied and will be reported at a later date.

LITERATURE CITED.

Grant, Avery R.

1937. A systematic revision of the genus Acmaea Eschscholtz, including consideration of ecology and speciation. Ph. D. thesis, University of California, Berkeley.

ACKNOWLEDGEMENTS.

The author wishes to thank Drs. Cadet Hand, Rudolf Stohler, and Paul Illg for helpful suggestions in preparation of this paper. He is also grateful to Boise Junior College for financial support in publication.

ADDITIONAL NOTES ON BERINGIUS

by

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Since publication of the description of Beringius eyerdami A. G. Smith in the July, 1959, "Nautilus," eight more specimens of Beringius have been submitted for study by Mr. Everett C. Stiles of Bellingham, Washington, from his private collection. These also were taken by trawlers in the vicinity of the type locality on La Perouse Bank, 40 miles west of Cape Flattery, in about 100 fathoms. Some of them, at least, can be considered to be topotypes of B. eyerdami.

Because the sculptural variation noted in the original

comments on Beringius from this locality is even more striking in these eight additional specimens, comments on them may be of interest. Six of the eight shells are fine, well-preserved specimens and contain the operculum. Five of these are full-grown adults; one is not fully adult but is perhaps three-quarters grown. Two are adults not living when collected.

Four of the eight are sculptured with the heavy spiral ribs and channels over the entire shells like the holotype of Beringius eyerdami. There is, however, considerable variation

among these four in the number and width of the ribs on the body whorl and especially in the width of the channeled interspaces. These variations certainly seem well within what is inferred to be normal limits for the species. The broad, low, rounded area or boss just inside the upper end of the aperture, noted as a feature of the holotype of B. eyerdami, does not occur on these shells and therefore this does not appear to be a constant sculptural feature of the species. Two of these four shells are illustrated on the accompanying plates.

The shell shown on Plate 13, fig. 1, is chosen because the coarse spiral ribs are bounded by very narrow, deeply-cut, spiral incisions unlike the broad square-cut channels found in the holotype and other specimens of what is considered to be the normal sculptural form of Beringius eyerdami (See Nautilus, 73 (1), pl. 2, figs. 3, 4, and pl. 3, fig. 1). The shell shown on Plate 14, figs. 1 and 2, is chosen because it has its nuclear whorls complete; in most adult specimens they are broken off and the remaining tip plugged with shell material. As nearly as can be determined, the nuclear whorls in this specimen are $2\frac{1}{2}$ in number, smooth, and chalky in texture, and gradually expand to meet the first post-nuclear whorl, the line of demarcation being indistinct due to erosion.

Two other shells in the series lack the heavy spiral ribbing entirely. Spiral ribs, when present, appear in a closely-spaced series on the outer canal. One of these is

shown on Plate 13, fig. 2. While this shell is a rather old, somewhat worn adult, a fairly sizeable unworn portion of the body whorl with periostracum intact shows a spiral sculpture of low, widely-spaced, narrow cords. In sculptural aspect it is like the one figured on Plate 3, fig. 3, of the "Nautilus" account with the exception that it has a relatively shorter spire, a more tumid body whorl, and lacks all but a very faint indication of spiral ribs on the canal and on the area immediately adjacent to it. Under the light-brown periostracum there is a white, chalky shell layer, and where this is worn off a layer of salmon-pink appears, corresponding to the color inside the mouth of the shell. The other specimen is an old eroded adult shell, showing little if any evidence of spiral sculpture on the postnuclear and body whorls, although it does have one or two heavy ribs at the base of the body whorl and the series of weaker and closely-spaced ribs on the canal. These two shells, and the one figured earlier (Nautilus, 73 (1), pl. 3, fig. 3) are still a problem. Whether they represent a smooth variant of the heavily ribbed Beringius eyerdami or another species or subspecies is a question yet to be answered.

The shell illustrated in Plate 13, figs. 3 and 4, seems to be a sculptural form intermediate between the normal, heavily-ribbed Beringius eyerdami and the smoother shells mentioned above. The heavy spiral ribs and channels are strong at the tops of the postnuclear whorls and the body whorl. On the

latter whorl they are replaced by a broad area above, and below the periphery sculptured irregularly by fine spiral striations, below which is a series of 5 or 6 low, closely-spaced cords, and below these toward the base occurs a series of 5 broad, strong, spiral ribs bordered by wide, deep-cut channels. The usual series of weaker cords occur on the canal. This shell certainly has some of the aspects of B. kennicotti (Dall) as represented by the less tabulate and more sloping upper portion of the body whorl and the somewhat more prominent transverse plications of which 13 can be counted on the body whorl and about 12 on the whorl just above it.

The shell illustrated in Plate 14, figs. 3 and 4, is a partly-grown specimen, collected alive, with an extraordinary set of nuclear whorls, which are complete and unbroken. The heavy spiral ribs and channels on body whorl begin below the periphery and are five in number. The usual series of 9 or 10 ribs are present on the canal. On the postnuclear whorls, above the sutures, there is a narrow but deep spiral groove marking off a single heavy spiral rib, above which there are about 5 widely-spaced, low spiral cords that are not at all prominent. The complete nuclear whorls are 4 in number, chalky white, and do not increase in diameter, giving them a straight-sided aspect. The sutures are well impressed and above them are what remains of a low spiral rib. Undoubtedly, these whorls are somewhat eroded as they show no evidence of any origi-

nal microsculpture which may possibly have been present when formed during early growth. Like the shell illustrated on Plate 13, figs. 3 and 4, this specimen has somewhat more prominent transverse plications, most evident at the shoulders of the whorls, with the upper portion of the body whorl sloping down from the suture. The inclination is to identify this shell as Beringius kennicotti. It is much like the shell illustrated in the Nautilus, 73 (1), pl. 1, fig. 3. If so, the range for the species is extended southward from Cook's Inlet, Alaska (Dall, 1921) to off the coast of Washington. Also, one is led to wonder whether the unusually long, straight-sided, set of nuclear whorls illustrated by this specimen may not be a major criterion for setting B. kennicotti apart from B. eyerdami and B. undatus Dall, provided this character is constant and not aberrant. Unquestionably the difference in the nuclear whorls shown on Plate 14, figs. 2 and 4, are major in nature and, when unbroken, could provide a sure means of identification.

According to Mr. Stiles (pers. comm., 31 Aug. 1958) the trawler "Paul L." (Captain Schultz), based in Puget Sound, is now bringing in specimens of the typical ribbed Beringius eyerdami from a depth of about 50 fathoms in Hecate Strait, off Queen Charlotte Islands, British Columbia.

Thanks are due to Mr. C. E. Crompton of the California Academy of Sciences for the excellent photographs used as illustrations for this paper.

LITERATURE CITED.

Dall, W. H.

1921. Summary of the marine shell bearing mollusks of the northwest coast of America, from San Diego, California, to the Polar Sea, mostly contained in the collection of the U. S. National Museum, with illustrations of hitherto

unfigured species. U. S. National Museum Bull. 112, pp. 90-91.

Smith, Allyn G.

1959. A new Beringius from the Pacific Northwest with comments on certain described forms. Nautilus, vol. 73, No. 1, pp. 1-9, pls. 1-3, July, 1959; vol. 73, No. 2, pp. 43-46, October, 1959 (Continuation).

ILLUSTRATIONS

Plate 13.

- Fig. 1. Specimen S-IV. Beringius eyerdami A. G. Smith, Length, 114 mm. Body whorl has 18 spiral ribs, the interspaces between them consisting of deeply cut narrow grooves, except toward base of body whorl.
- Fig. 2. Specimen S-II. B. cf. B. eyerdami A. G. Smith, 132 mm. Heavy spiral sculpture lacking entirely. Spirals on body whorl consist of low, widely-spaced, narrow cords.
- Fig. 3. Specimen S-VII. B. cf. B. kennicotti Dall. Front view. Length 133 mm. Spiral sculpture intermediate. Heavy spirals and channels at top of penultimate whorls only, and at top and on base of body whorl.
- Fig. 4. Specimen S-VII. Back view.

Plate 14.

- Fig. 1. Specimen S-V. B. eyerdami A. G. Smith, Length 128 mm. Body whorl has 17 heavy spiral ribs. Nuclear whorls complete.
- Fig. 2. Specimen S-V. Nuclear whorls, enlarged.
- Fig. 3. Specimen S-III. B. cf. B. kennicotti Dall. Not quite adult. Length 108 mm. Back view showing the extremely long set of nuclear whorls and spiral ribbing on the posterior area of postnuclear whorls.
- Fig. 4. Specimen S-III. Nuclear whorls, enlarged.

All specimens from about 100 fathoms, La Perouse Bank, 40 miles west of Cape Flattery, Washington. E. C. Stiles Collection.



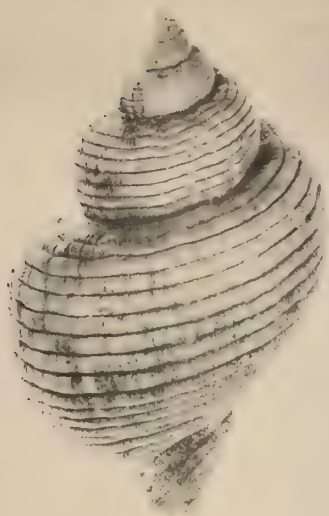


Figure 1

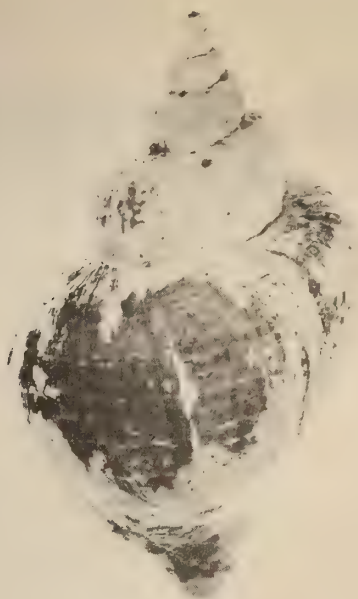


Figure 2



Figure 3

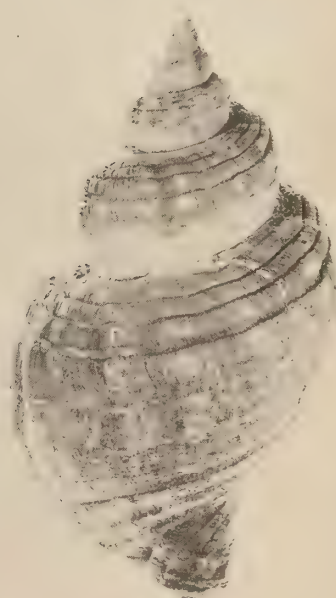


Figure 4



Figure 1



Figure 2



Figure 3



Figure 4

NOTES & NEWS.

LOW HERMIT CRAB MIGRATION RATES

by

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The short-distance variation in the incidence of a barnacle, *Trypetesa lateralis* Tomlinson (1953), which burrows into snail shells occupied by hermit crabs and has a life span probably exceeding one or two years, gives us indirect evidence that hermit crabs do not move along the coast at any appreciable rate.

The barnacle has been kept alive by the author in an aquarium for over a year without appreciable growth. Analysis of population composition indicates that in the field these animals live at least a year and probably longer.

Favorable shells occupied by the usual species of hermit crabs are found in rocky areas throughout central California. In two places, however, the barnacle is found in appreciable quantities within a few hundred yards to a few miles from areas with the same species of crabs and shells which exhibit few or no barnacles. The supposition that the barnacle cannot live in this area is understandable, but the lack of dead animals or burrows indicates that crabs have not migrated into the area from nearby habitats favorable to the barnacle.

Uneven distributions within one collecting point were seen at Moss Beach, San Mateo County, California. In the region immediately off "Dan's Motel"

at the north edge of the city limits, the barnacles are found in typical abundance (18% incidence in 3,237 specimens), while just a few hundred yards south, off of Nye's rock, the incidence falls to 4.9% of 264 specimens collected. South about two miles along essentially continuous reef, around Pillar Point, no barnacles were found in 240 shells.

Another example is seen on the Monterey Peninsula, where no barnacles were found in 302 "hermit crab shells" at Point Cabrillo (where the Hopkins Marine Station is located), yet just 3000 yards west lies Point Pinos, where the incidence of barnacles in 665 of the same shells proved to be 17%. In this case sizeable sandy beaches intervene.

LITERATURE CITED.

Tomlinson, Jack T. A burrowing barnacle of the genus *Trypetesa* (order Acrothoracica). J. Wash. Acad. Sci. 43 (11): 373-381. November, 1953.

BATILLARIA CUMINGI, INTRODUCED
CERITHIID IN ELKHORN SLOUGH

by

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On March 26, 1930, Paul Bonnot of the California Department of Fish and Game examined a shipment of seed oysters from Japan intended for Elkhorn Slough (near Monterey, California) and noted

among other mollusks, the presence of "Potamides (Batillaria) multiformis (Lischke)". In April, 1936, he sent a single specimen of a Batillaria from Elkhorn Slough to the California Academy of Sciences, thus confirming its establishment there. I am indebted to Mr. Allyn G. Smith of the California Academy for information about the collection and help with the references.

Only during the past two years has this Elkhorn cerithiid been noted in numbers on collecting trips from the Hopkins Marine Station. I collected a sample of these snails on August 20, 1959. The shells varied in length from 10 to 34 mm. and averaged about 25 mm. in length. All were long and slender, a few with traces of varices on the early whorls (10 per whorl), and varied in color from light brown to nearly black. Of 467 specimens examined, 26.4% showed the presence of a white band on the two most posterior spiral cords.

There are two species of highly variable Batillaria with overlapping ranges throughout Japan (Kuroda and Habe, 1952, p. 40). B. multiformis (Lischke, 1869) varies from smooth and slender to stubby and heavily sculptured. B. cumingi (Crosse, 1862) was noted by Lischke (1869, p. 74) to vary especially with the white sutural band as above. Dr. T. Habe, who was recently at Stanford, confirmed the identification of the Elkhorn species as Batillaria cumingi. It is likely that Bonnot had this species.

I found the Batillaria restricted to the extreme northwestern arm of the slough,

which connects with the major body of water by a small culvert. Restricted outflow maintains high water in this arm, a condition said to be relatively recent. The salinity of this body was subsequently found to be 44‰, a salinity higher than most marine organisms tolerate. However, such limited circulation might lead to brackish conditions during the winter months of heavy rains. A profuse growth of the filamentous green alga Enteromorpha sp. is characteristic of this arm, although sporadic elsewhere in the slough. The B. cumingi were present in great numbers: at high water mark a density of about 800 per square foot was determined; in the Enteromorpha, 250 per square foot were found. None of these were dead.

Living animals are easy to maintain in the laboratory. They are able to live in dishes of sea water for weeks and were able to withstand dessication for over 16 days (when the experiment was terminated). Their food may consist largely, if not entirely, of the Enteromorpha, both green and partially decomposed, which they consumed in the laboratory. The abundance of the Enteromorpha could account for their high density. Locomotion of the animal is slow; it must extend itself and then contract in order to drag the shell.

In view of their large numbers, the appearance of these snails is of ecological significance. Cerithidea californica (Haldeman) occupies a similar niche in southern California, but has not been reported from Elkhorn Slough, although Dall (U. S. N. M. Bull. 112) gives Bolinas Bay as its northern range limit.

Rapid establishment of Batillaria cumingi in Elkhorn Slough may have been facilitated by the absence of niche competition. Specimens of B. cumingi in the California Academy collection have been received from Tomales Bay in 1955 and Sausalito in 1958, probably from separate introductions. They were not recorded as common from these localities. I expect that they are restricted to the northwestern arm of Elkhorn Slough due to the absence of major tidal fluctuation, since these rather sluggish animals seem able to proliferate under relatively stagnant conditions.

LITERATURE CITED.

Bonnot, Paul.

1935. A recent introduction of exotic species of molluscs into California waters from Japan. Nautilus, vol. 49, no. 1, pp. 1-2.

Crosse, H.

1862. Description d'especes marines recueillies par M. G. Cuming dans le nord de la Chine. Jour. Conchyliologie, vol. 10, no. 1, pp. 51-57, 2 pls.

Kuroda, T. and T. Habe

1952. Checklist and bibliography of the recent marine mollusca of Japan. L. W. Stach, publisher, Tokyo. 210 pp.

Lischke, C. E.

1860. Japanische Meeres-Conchylien. Cassel. vol. I, 192 pp., 14 pls.

NOTE ON AN AGGREGATION OF APLYSIA CALIFORNICA (COOPER).

by

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Aplysia californica (Cooper, 1863) is the largest of the California gastropods, so that its presence in large numbers is a striking sight. On September 20, 1959, these mollusks were observed in considerable numbers along the jetty at the mouth of Bodega Harbor, Sonoma County, California. Some egg masses were also seen at that time. The water was too turbid on that date for prolonged observations. On September 27, the water was somewhat less turbid, and it was possible to get a better look at the aggregation. Many individuals of Aplysia could be seen along the entire length of the northwest face of the jetty. During diving with mask and snorkel it was noted that most of these animals were concentrated at a depth estimated to be from about one foot above to one foot below mean lower low water. Most or all animals were in groups of two to seven individuals. Copulation was taking place in many of these groups and two individuals extruded semen on being handled. Egg masses were abundant at the level of the Aplysia. One mass, removed from the middle of a circle of seven animals, filled a two quart container. The eggs were encased in firm gelatinous strings, ranging in color from yellow through greenish tan to tan, each string about two mm. in diameter, and

of great length. The eggs were arranged in compartments within these strings; three or four such compartments were present in each cross-section. Two compartments, picked at random, contained 208 and 356 eggs respectively. The masses were entwined with fixed algae or were attached to rocks, evidently having stuck firmly on extrusion.

It had been hoped that an estimate of the total number of Aplysia present on the jetty could be obtained, but the cryptic coloration of the animals, together with turbidity of the water, made an accurate estimate difficult. Twelve individuals were removed from a stretch of the jetty approximately fifty feet long. Thirty minutes later several more Aplysia were present in the middle of this area, having evidently been overlooked on the first search. Others were also probably present.

All Aplysia seen were on or between the large rocks of the jetty, none being seen on the nearby sand bottom. It would seem probable that the large number of Aplysia present was part of a spawning aggregation. Detailed observations on such an aggregation might shed light on some interesting problems of orientation.



METHODS & TECHNIQUES

SEA WATER AQUARIA IN THE HOME— WITHOUT FUSS

by
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How often, while shell collecting, have you regretted the necessity of killing the animals you seek? How much more interesting to be able to observe them alive and at leisure, to "raise" your collection. Conchos, as the Australians call shell collectors, can now become big (?) game hunters and bring them back alive.

Operating a sea water aquarium at home is feasible, even if you live relatively far from the ocean. Pet supply shops can furnish a 10 gallon aquarium with a circulating-filtering system for less than \$25. For about \$10 more, a 15 gallon tank, so made that no metal ever touches the water, can be purchased. This construction is a very desirable feature, as metal ions are toxic to many marine invertebrates. Other sizes are also available.

Once the tank is filled, it is not necessary to replace the water unless it goes foul. The recommended water level (determined by the type of filter system) is kept up by the addition of distilled water. (For certain types of animals it may be necessary to use only water that has been distilled in glass tubing...those ions again.) We have developed

one refinement of this procedure: when it is apparent that a lot of salt has been lost with the evaporating water, we occasionally add sea water instead of distilled. An inexpensive hydrometer will indicate when and if this is necessary. However, a fairly great range of salinity appears acceptable to whatever animals we have collected to date.

Since mid-October, 1958, we have had three 10 gallon tanks, two of which are equipped with Miracle Filters. These are designed for use with "pea gravel" which comes in three sizes. We prefer the medium. Sand is considered undesirable because burrowing animals hidden in it may die and decay, thus polluting the water. However, to provide as natural a habitat as possible, we choose to risk this danger. Above two to three inches of the gravel, we have used varying amounts of beach sand.

Small mollusks seem to have a penchant for crawling up the Miracle Filter tubes--and falling into them. To prevent this, we fill the tube mouth loosely with plastic screening.

The third tank contains only water, as it is kept for specific observations during which we want the animals constantly in view. In it we use a charcoal filter. Each type of equipment seems well suited to its purpose.

Water temperatures between 18° and 22° C. appear to be satisfactory for our mixture of intertidal organisms. Although most of them survive even at 25°, it is almost certain that some deaths have

been attributable to temperatures above 23°. There should be no danger, in the home, of the water getting too cold.

An air stone, hooked up to the filter system, helps to keep temperature down by evaporation (although it will cause considerable loss of salt). During a recent hot spell, the most effective cooling measure has been the use of commercial plastic "pillows" that are frozen and then placed in the water. Similar products that come only in metal containers (Dri Cubes, Scotch Ice, etc.) can be wrapped in plastic bags to keep the metal out of contact with the water. Distilled water ice cubes reduce the temperature most rapidly of all. They will, of course, dilute the salt water, and can only be used when it is necessary to raise the water level anyway.

Shrill warnings come from all sides against keeping any vegetation in salt water aquaria (none is known that will root and keep growing) as it will rot and foul the water. Perhaps because of the varied population of our tanks -- we are always careful to have several vegetarians (Norrissia, Tegula, Astraea, Barleeia) working for us -- our animals seem to thrive best when we ignore this prohibition. Eel grass does finally turn brown and unlovely after three to four weeks. Ulva, however, will last -- so far as long as we have had it on hand, and there is a green, mossy alga that has stayed fresh indefinitely.

One is constantly cautioned

not to overload an aquarium. Ignorance and luck have been on our side — and/or perhaps, a purely fortuitous balance. We have had gastropods, pelecypods, nudibranchs, crabs, tide-pool fish, shrimp, marine worms, sea anemones, urchins, starfish, and even a small octopus (he had to be put back — he was indiscriminately devouring our populace) at one time. In numbers, over 100 individuals have lived together in a tank without visible ill-effect.

(A word on "bringing them back alive": it is best, unless you can keep specimens in cool aerated water, to place them in damp seaweed or a wet burlap sack, rather than in a pail of water. They will, under these conditions, conserve their energy and their oxygen.)

It would appear from our experience to date that a complete water change should rarely be necessary. Murky water, an increase in dying animals, have prompted us to make such a change three times, and it's possible that this drastic action was not required in each case. Removing dead animals promptly is good practice, although sometimes they provide a fine meal for the scavenging species.

Many exciting — and valuable — observations can be made in home aquaria, that are likely to give a quite accurate picture of life in the tide pools and the open sea. Our short experience has provided many hours of real adventure and entertainment — plus a realization of how much there is to learn about successful

maintenance of our tanks. For instance, eggs of many species have been laid, though, with the exception of the tiny *Barleeia*, few — if any — have hatched, and none have survived. Different techniques, and probably a different setup, may be required to raise young Marine forms.

The only rules we have come across have been formulated from experience with tropical fish. A predominantly moluscan fauna is, obviously, quite different. And the only operational formula that we have evolved is to ignore all rules! We cannot, so far, assign any reasons for either our failures, or our successes.

Editor's note:

The adaptability to relatively large changes in temperatures and to the constant maintenance at what might be termed room temperature is true only of the fauna of Southern and Lower California; in our experience, northern forms require a fairly constant temperature of 14° C.; as much as 18° C., attained on occasion through failure of the cooling equipment, has resulted in the death of all forms, except some sea anemones.



INFORMATION DESK

HOW TO BUILD A PRIVATE COLLECTION
WHICH IS SCIENTIFICALLY VALUABLE, cont.

Dr. Rudolf Stohler
Department of Zoology,
University of California, Berkeley

Part II: Accessioning.

Many institutional collections use a so-called accession book, which is a permanent record. In it are entered the various lots of specimens as they are received. The lots may be numbered in one of two principal ways. Some institutions give a so-called accession number to a whole collection received at one time from one source, while others use different numbers for each lot contained in such a collection. By collection is meant - in this connection - all the material collected in the field at one time and not yet further processed. However, if separate numbers are assigned to each species then a certain amount of processing of a collection must take place before accessioning. The different species must be segregated out of the whole collection and, at least tentatively, identified. A lot then may consist of a single specimen or a large series; but all in the same lot with the same number (accession number) should be the same species from the same locality. In the accession book all pertinent information accompanying the specimen must be entered; next the accession number is affixed in some manner to the specimen, preferably in such a manner that the number cannot become lost unless the specimen is lost, or vice versa. With larger shells the accession number may be written with some kind of permanent ink in an inconspicuous place, often on a smooth surface. In many gastropods the only suitable surface seems to be the inside of the lip of the shell. Smaller shells may be placed into shell vials or so-called veterinary

gelatine capsules. In that case, the accession number must be written or printed on a piece of very high grade paper, one that is resistant to pest attack. This small piece of paper must be included in the shell vial or in the gelatine capsule. The field notes, if they have been transcribed onto labels for each species lot, should, of course, be included in the collection. However, if the collector does nothing more than keep a complete accession record, as described, and properly numbers his specimens, his collection will be a valuable addition to any museum. Of course, proper labeling and cataloguing will further increase the value.

1673

UNIVERSITY OF CALIFORNIA
DEPARTMENT OF ZOOLOGY COLLECTION*Acmaea funiculata* (CARPENTER)

seaward side of N. Isld., Los Coronados, Baja Cal., Mex.
in 150 feet; on top and sides of large rocks, ledges;
19 July 1957 Fager, Ghelardi, Stewart, Clarke, coll.
32° 27' N; 117° 11' 45" W

Fig. 1. Sample Label as used in the
Department of Zoology in Berkeley

Part III: Labeling.

After a lot has been identified, i.e., the scientific name of the particular species has been completely ascertained, a label may be - or, rather, should be - prepared to accompany the specimen forever after. A good label should contain all the information originally obtained, in addition to the name of the species. Aside from locality information, date, collector, identifier, the label should bear somewhere also the accession number. It is unwise

to use special codes unless these codes are almost self-explanatory or consist of abbreviations in common use; if it seems desirable to use other codes, such as colored dots or special signs, then it should be an indispensable duty of the collector to provide ample explanation of his code, readily available at all times to any one who may examine the collection. In the collection of the Department of Zoology at the University of California we use the type of label as is shown in Figure 1. The paper is 100% rag content; the species name is printed by letter press; all other information is added by hand with India ink. The accession number is stamped on the back of the label and written in the margin of the front after all shells have been marked. Geographical longitude and latitude are given at the bottom of the label in order to facilitate the arrangement of the collection. Since our interest lies in the variability of the various species, our collections are arranged, for each species, strictly from South to North.

(to be concluded)



BOOKS, PERIODICALS, PAMPHLETS

Book Review

MOLLUSCS - John E. Morton;
Hutchinson University
Library, London. 232 pp.,
23 figs. in text, 1958.
Approximately \$1.80, imported.
(Also announced for U. S.
publication during the summer

of 1959 by Rinehart, New York,
at \$1.50.)

There are few books on molluskan anatomy available and fewer still that the nonspecialist can understand readily. Morton's little volume therefore comes as a welcome introduction to the subject. Emphasis is not only on the actual range of modification in molluskan soft parts but also on the significance of these -- how the various adaptations enable the clams or the snails to live and feed and reproduce under the different ecologic conditions into which they have radiated. Dr. Morton, who is a professor of zoology at Queen Mary College, London, has not only brought together very competently the scattered literature on life and habits of mollusks but, being a skillful draftsman, has illustrated the points he makes throughout the text with neat and helpful line drawings. His treatment of Gastropoda is especially good. Students of the Pelecypoda (called Lamellibranchia in this book, a term preferred by zoologists, especially the British) may not agree with Morton in accepting Douvillé's classification as basic, for it has seemed to many of us as more an interesting speculation than a practical means of separating bivalve groups. This is a minor reservation, however. On the whole, the book is well worth recommending to anyone who takes a serious interest in the study of Mollusca. It is divided into eleven chapters, as follows: Introduction and general features; External form and habits -- Gastropoda; Lamellibranchia and Cephalopoda; Mantle cavity and gills; Feeding and digestion; Blood, body cavity and excretion; Sex and reproduction; Nervous system, sense organs and behaviour; The evolution of the Gastropoda; The

Lamellibranchia and their classification; The first and last cephalopods. There are also two appendices and a table showing Thiele's classification, besides a 7-page bibliography and an index.

A. Myra Keen

MARINE MOLLUSCA OF POINT BARROW

ALASKA — Nettie MacGinitie.

Proc. U. S. Nat. Mus., Vol. 109, pp. 59-208, 27 pls. Copy received at California Academy of Sciences, October 2, 1959.

This excellent paper is the result of several years' work on the large collection of mollusks obtained by dredging and otherwise in the near vicinity of Point Barrow by Dr. George M. MacGinitie while he was Director of the U. S. Naval Arctic Research Laboratory. It forms the only comprehensive treatise on Arctic Ocean shells which has been published in North America. The difficulties involved in its preparation must have seemed almost insurmountable many times due to the extreme variation of many species in those cold waters.

The table showing the distribution of the fauna contains 126 species and varieties. The Gastropoda contains 82 species including 3 nudibranchs and 2 pteropods. There are 2 chitons, 2 cephalopods, and 40 pelecypods. A new subgenus of *Thracia* (*Lampeia*), 3 new species and one new name are described. It is a pleasure to note that these new names honor faithful and highly skilled Eskimo assistants.

The most conspicuous family

in the fauna is the Buccinidae. Species and varieties as now understood have greatly multiplied so that in this report 13 are recognized and discussed.

Nearly all of the species are illustrated with adequate figures. In some cases there are enough figures of a single species to give some idea of variation encountered. This is so great in numerous genera that some students would be inclined to give a separate name to every specimen collected. Fortunately Mrs. MacGinitie chose a conservative course. The bibliography covers 13 pages and the paper is indexed by genera and species.

Students of California mollusks will find many interesting notes and distribution records in this paper. In some cases the author was simply unable to disentangle the multiplicity of names given by workers in different parts of the Arctic. It is adequately pointed out that conditions of temperature in the Arctic Ocean are much more constant than in any other, and this, no doubt, accounts for circumpolar distribution of many organisms.

This paper, together with the earlier one by G. E. MacGinitie (Distribution and Ecology of the Marine Invertebrates of Point Barrow, Alaska. Smith. Misc. Coll. Vol. 128, No. 9, Nov. 30, 1955, 201 pp., 8 pls., 2 text figs.) now make it possible for the field worker in Arctic Alaska to obtain information on a considerable portion of the marine fauna.

G. Dallas Hanna

PROCEDURE IN TAXONOMY - Schenk & Masters; Third Edition by A. Myra Keen and Siemon William Muller; SECOND PRINTING (with substantial additions). Stanford University Press, 1959.

It is unfortunate that the very important fact that this second printing is quite up-to-date is lost in the parenthetical statement "(with substantial additions)". In this reviewer's opinion it would be justifiable to call this the FOURTH, enlarged edition. As its predecessors, this excellent book is an indispensable tool and constant source book for the active worker in taxonomy. The "opinions" of the international commission on nomenclature are given by title (because of copy-right laws it is no longer possible to give a summary of each) through May 22, 1959; equally complete is the list of "Titles to Declarations" and "Directions Issued" by the international commission on nomenclature.

R. Stohler

IMPORTANT ANNOUNCEMENT

The following scientists have agreed to serve on the Editorial Board of the Veliger, beginning July 1, 1960.

Dr. J. Wyatt Durham, Professor of Paleontology
Dr. Cadet Hand, Associate Professor of Zoology
Dr. Frank Pitelka, Professor of Zoology
Dr. Ralph I. Smith, Professor of Zoology
(all from the University of California, Berkeley)
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Dr. G. Dallas Hanna, Curator, Department of Geology
Dr. Leo G. Hertlein, Associate Curator, Department of Geology
Mr. Allyn G. Smith, Research Malacologist
(the last three named from the California Academy of Sciences)

Manuscripts in final form accompanied by a good carbon copy, should be sent to the Senior Editor, Dr. R. Stohler
Department of Zoology
University of California
Berkeley 4, California

AMU-PD

CALL FOR PAPERS

If you wish to present a paper at the forthcoming convention of the American Malacological Union-Pacific Division at Pacific Grove, on the Monterey Peninsula, June 22 through 25, 1960, then please get in touch immediately with the undersigned. If you wish to attend the convention, please address Mrs. Lucille Zellers, 714 Elm Street, El Cerrito, for details.

Rudolf Stohler, Chairman, AMU-PD
c/o Department of Zoology
University of California
Berkeley 4, California

ERRATA

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page 71, second column,

line 22: for corral read coral

line 38: for (1958) read (1950)

Moll.

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University of California, Berkeley

A REVISION OF THE STATUS OF CYPRAEA OSTERGAARDI DALL

by

Crawford N. and Jean Cate (Los Angeles, California)

and

Clifton S. Weaver (Honolulu, Hawaii)

(Plate 15)

Among the many significant discoveries made by the Hawaiian Pele Expedition of 1959, one of the most interesting is the taking of the second live specimen of Cypraea ostergaardi Dall. Finding this specimen has served to clarify the status of two separately described species, C. ostergaardi and C. alleni Ostergaard. It is the considered opinion of the authors that these two species are synonymous, C. alleni representing the live specimens, and C. ostergaardi as formerly known, representing a subfossil shell of identical characteristics.

A brief history of these shells discloses that the first specimen was brought up in the dredging of Honolulu Harbor in 1915. Ostergaard recognized it as distinctly different from a large group of subfossil Cypraea helvola brought up at the same time, and in 1920 described it as Cypraea pacifica. Five specimens were taken at that time, all dead. The type specimen is in Prof. Ostergaard's collection.

In 1921, Dall pointed out that the name Cypraea pacifica had been preoccupied by a species of Trivia described by Gray in 1832. He therefore renamed the species Cypraea ostergaardi in honor of the original author.

In 1949 Charles A. Allen of Honolulu, in his extensive dredgings in the Hawaiian area, brought up a shell that appeared to be an entirely new species. Dredged in approximately 80 feet of water off the island of

Kauai, this unique specimen was described by Ostergaard in 1950 as Cypraea alleni.

During August, 1959, five dead specimens of Cypraea ostergaardi were dredged by the Pele Expedition; one was taken in 90 feet of water off Diamond Head, Oahu; the other four were dredged in from 50 to 75 fathoms on a coral-rubble and sand bottom off Keehi Lagoon, Oahu. These shells are identical in form and color to the pellucid specimens found in the early Honolulu Harbor dredgings from which the original C. ostergaardi was described.

On September 22, 1959, during the final week of the Pele Expedition, a live specimen exactly matching all the features of the holotype of Cypraea alleni was brought up in the dredge from 60 fathoms on a coral-rubble bottom in Keehi Lagoon, Oahu--the same locality where four of the five pellucid specimens of C. ostergaardi were found during the previous month. This specimen was sent to the senior author for study; at the same time, three specimens of the pellucid C. ostergaardi were on hand for the same purpose. When all four of these shells were lined up together it was obvious they were one and the same species, varying from one another in no respect except color and markings. This substantiates Ostergaard's observation in his publication (1958) of the species C. alleni, as follows: "This species is probably most closely related to C. ostergaardi Dall which it resem-

bles, in form, teeth, and aperture, but departs radically from it in its markings."

Professor Ostergaard has examined this group of four shells (the same group figured in Plate 15), and agrees that they are all identical structurally. All who have seen the four shells in question agree that the only difference between them lies in the color and markings. The question here now resolves itself as to whether color and markings alone are a valid basis for the separation of two otherwise identical species.

We propose that the two species be placed in synonymy, with the two known living specimens of the former Cypraea alleni being the true living C. ostergaardi, the pellucid specimens representing the fossil form. We base this proposal upon the following reasons:

1. The species heretofore known as Cypraea ostergaardi has never been taken alive.
2. Examination of all the pellucid forms reveals minute deposits of lime in the interior of the shells, as well as in the canals and the interstices between the teeth. This tends to substantiate the aging of these shells.
3. All of the recently dredged specimens of both types, living and pellucid, with one exception, were taken at the same depth and same locality, but in different dredge hauls and on different days. This seems to establish that both types share the same habitat.
4. Except for the rich rose-brown color on the dorsum of the new live specimen, and the accompanying tiny white spots which represent the final stage in color-development of the mature shell (and possibly the first stage to disappear in the process of becoming a fossil), all other color features are identical in all the specimens.

5. Despite every precaution to keep the live shell away from strong light during the five weeks that it has been under observation on the mainland, the dorsal color has perceptibly faded to the point that it now more closely resembles the pellucid form than when first received. This tendency to fade very rapidly after the death of the mollusk is typical of many species of Cypraea (for example, C. sulcidentata, C. leviathan, C. helvola, etc.) and emphasizes the importance of considering the color change as affecting the final analysis of a species.
6. It is the opinion of the authors that color and pattern alone cannot constitute the basis for a new species.

Therefore, from the foregoing conclusions, and from additional observations made from the newly dredged live shell, we offer the following emended description of Cypraea ostergaardi Dall:

Shell solid, bluntly ovate, somewhat flattened though humped posteriorly; margins thickened, pitted above though partially obscured by an overlapping callus at the sides. The pits are most prominent over the terminal collars, with the brown spots likewise concentrating here to suggest a continuous brown arc of shading. Teeth fine, well defined, extending narrowly the length of columella and labial margin; terminal ridge strong and oblique; columella broad, flat, becoming concave at the fossula; the last five columellar teeth extend in a broken line over the fossula. Aperture narrow, curved, constricted anteriorly. Dorsum a rich rose-brown with a faint lavender tinge, generously covered with dark brown spots; a final irregular covering of very fine white spots creates ocellae on many of the larger uppermost brown spots. The

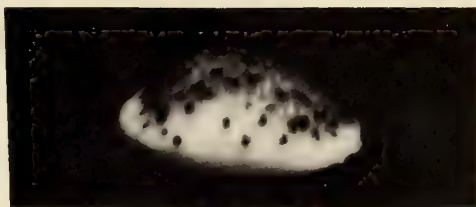


Figure 1a

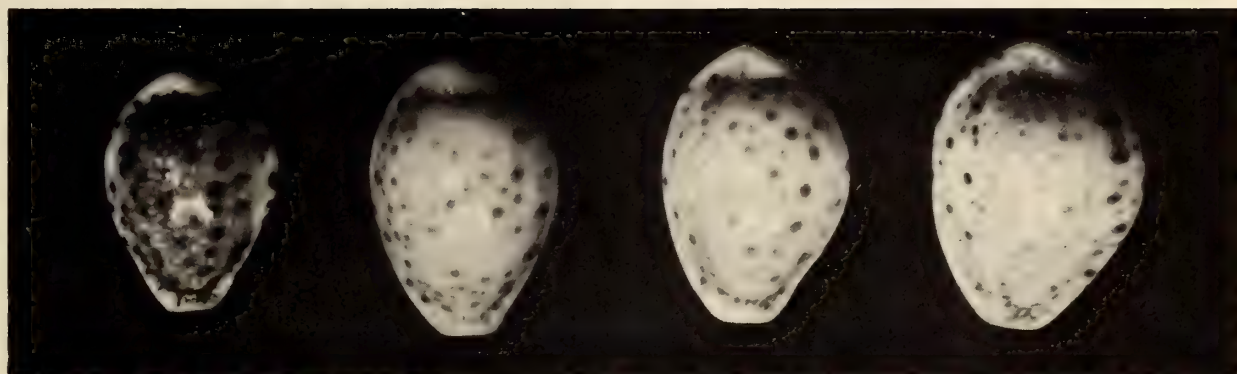


Figure 2a

Figure 2b

Figure 2c

Figure 2d

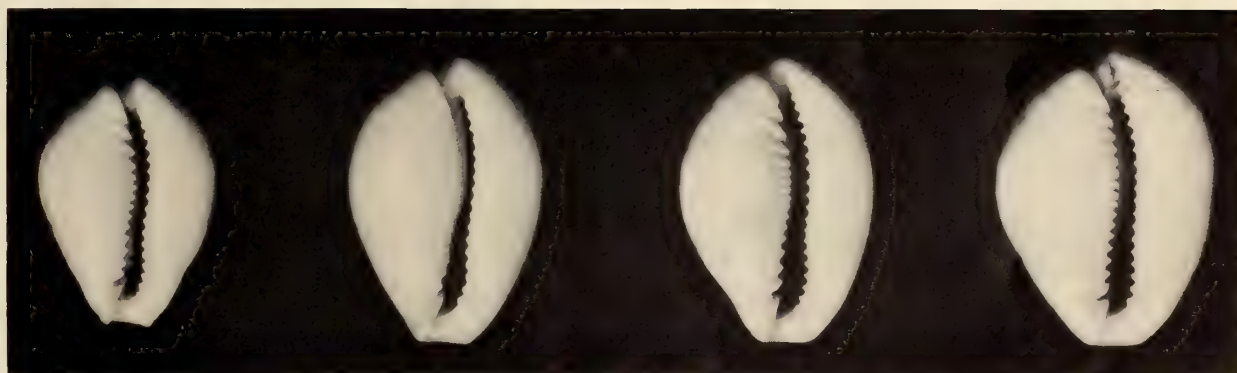


Figure 3a

Figure 3b

Figure 3c

Figure 3d

Cypraea ostergaardi DALL

Figures 1a, 2a, & 3a: Live Collected Shell. Figures 2b, 2c, 2d, 3b, 3c, & 3d: Subfossil Shell.
Figure 1a: Side View. Figures 2a, 2b, 2c, & 2d: Dorsal View. Figures 3a, 3b, 3c, & 3d: Basal View.

MEASUREMENTS: Shell a - Length 17.4 mm, Width 12.8 mm, Height 8.9 mm;
Shell b - Length 19.9 mm, Width 13.9 mm, Height 5.7 mm;
Shell c - Length 19.8 mm, Width 14.0 mm, Height 5.3 mm;
Shell d - Length 20.6 mm, Width 15.9 mm, Height 10.5 mm.

margins, teeth, and base are white, except for a few large brown lateral spots extending into the margin.

Cypraea ostergaardi differs from *C. helvola hawaiiensis* Melvill, with which it compares favorably, by the definitely large and distinct brown spots, the finer teeth, and the pure white color of base, teeth, and margins. The heavier teeth, the constant pattern quality, and the ferruginous base, teeth, and margins of *C. helvola hawaiiensis* constitute a very conspicuous separation of these two species.

We extend our grateful thanks to Mrs. Mary Eleanor King of Honolulu, sponsor of the Pele Expedition, for making it possible to clarify the relative positions of these two shells; also to our many kind friends for their support and encouragement,

including Professor Jens Ostergaard, Dr. Myra Keen, Dr. Rudolf Stohler, Dr. Leo Hertlein, Allyn G. Smith, Dr. G. Dallas Hanna, the late Lloyd E. Berry, and Gale Sphon. We greatly appreciate the cooperation and help of all these fellow-conchologists in the preparation of this paper. The photographs were made by Mr. Lowell Weymouth.

LITERATURE CITED.

- Dall, W. H.
1921. Nomenclatorial Notes.
Nautilus, vol. 35, p. 50.
Ostergaard, J. M.
1920. A New *Cypraea* from Hawaii.
Ibid., vol. 33, p. 92, pl. 11.
1950. A New Species of *Cypraea* from Hawaii. *Ibid.*, vol. 63, pp. 111-112, pl. 8.

A NEW OPISTHOBRANCH OF THE GENUS AGLAJA IN SAN FRANCISCO BAY

by

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and

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(Plate 16)

The diversity of the opisthobranch fauna in San Francisco Bay has long been overlooked, perhaps due to the variety of large and colorful forms on the outer shores of the California coast. But, although the additions to the San Francisco Bay fauna recently (Hand and Steinberg, 1955) and herein described are small and rather inconspicuous, they are nonetheless of considerable interest.

In the course of sampling the benthic fauna off Point Richmond (Jones, 1954), numerous specimens of a cephalaspidian opisthobranch belonging to the genus Aglaja were

found. They were quite unlike any of the six other species of Aglaja known from the West Coast of the Americas (see Tryon and Pilsbry, 1896, and MacFarland, 1924) and further investigation revealed them to be new to science.

Aglaja nana sp. nov.
(Plate 16)

Diagnosis.--Aglaja: body elliptical in outline, convex, without appendages. Anterior (cephalic) shield approximately 1/3 length of body and nearly as broad as long; anteriorly

emarginate and posteriorly overlapping posterior shield slightly. Posterior shield produced posteriorly into two lobes separated dorsally by a shallow medial notch and not joined ventrally. Flagellum on either lobe absent but ventral wing of left lobe sometimes larger and produced more posteriorly than that of the right lobe.

Parapodia small, flattened against body and reaching only to ventral edge of shields. Foot elliptical in outline, broad; attached anterior to middle of body; anterior border weakly bilabiate. Head small, not distinct; mouth pore-like. Gills bipinnate, lying in cavity above foot and below shell, posteriorly on right side.

Color of living animal translucent greyish white marked with irregular black flecks and small yellow-brown dots on dorsum, foot, and both inner and outer surfaces of parapodia; occasional larger opaque white spots present. Brownish-yellow internal organs showing through body wall. Gills pale translucent yellow.

Shell (figs. 3, 4) internal, nearly completely calcified but fragile; slightly longer than broad. Cuticular area restricted to narrow border along all but extreme posterior (apical) margin. Spire solute; nucleus consisting of at least two volutions. Large outer whorl slightly convex dorsally, directed downward at right posterior margin but not produced into projecting process.

Buccal mass strongly muscular. Radula and jaws absent.

Length of preserved type specimen (figs. 1, 2), 9.8 mm.; width, 4.2 mm.; height, 4.3 mm. Length of shell figured (figs. 3, 4), 4.9 mm.; greatest width, 3.6 mm.

Other specimens taken with the holotype and herewith designated as paratypes, differ in no discernible way from the holotype.

Holotype specimen.--U. S. N. M. Cat. No. 575,426.

Paratype specimen.--Calif. Acad. Sci. Dept. Geol. type collection No. 2238a.

Occurrence.--Type Locality: Richmond Yacht Harbor, Richmond, California, (approx. 37°55' N; 122°21' W) --collected "on floating old piles, under wharf" by Dr. Cadet Hand, May 5, 1956. Previous record: at 50 out of 65 stations in Richmond shoreline survey--collected with Eckman grab sampler on mud bottom in 6-37 ft. More abundant in shallow water (Jones, 1954, as Aglaja sp.). Other New Records: Berkeley Yacht Harbor, Berkeley, California--collected with epibenthic dredge in 5-30 ft. by Meredith Jones, July 20, 1954; off Treasure Island, San Francisco Bay, California--collected with epibenthic dredge by Meredith Jones, October 14, 1956.

Discussion.--Small specimens of Aglaja nana have been taken repeatedly in dredge hauls in San Francisco Bay near Point Richmond, in the Berkeley Yacht Harbor, and near Treasure Island. The largest specimens taken in deep water were never more than 3 mm. in length. The animals collected on floating piles at Richmond Yacht Harbor, from which the holotype has been selected, were much larger. Although this habitat appeared to be very different from the Bay bottom, Dr. Hand also reported seeing a number of small Mya which were lodged in the detritus fouling the piles so that the actual conditions may have been more like the bottom of the Bay than those on vertical wharf piles. An egg mass, presumably that of Aglaja nana, was collected at the same time.

The shell of Aglaja nana is similar in shape to that of A. diomedea (Bergh, 1894) but is less heavily calcified and is not as markedly produced at the right posterior margin as is that of A. diomedea. In addition, the spire is more solute

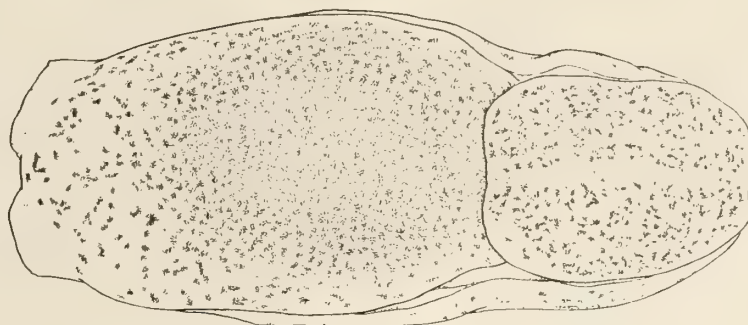


Figure 1

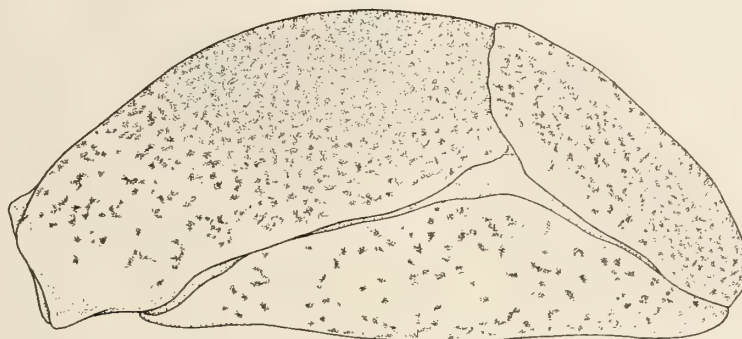


Figure 2

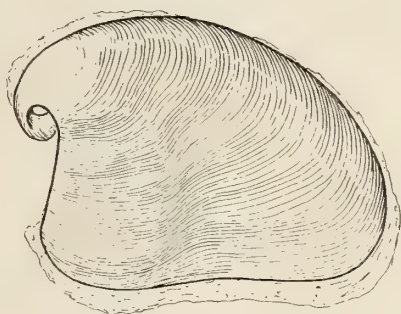


Figure 3

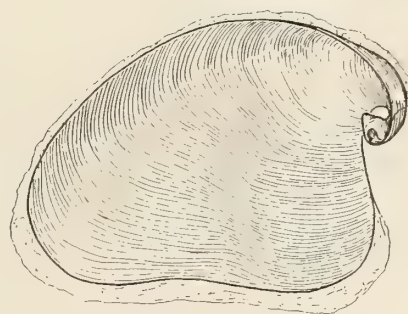


Figure 4

Aglaja nana spec. nov.

Figure 1. Holotype from above. Figure 2. Holotype from right side.
Figure 3. Shell from above. Figure 4. Shell from below.
(all figures 10 times natural size)

in our species.

Of the seven species now known from the eastern shores of the Pacific, Aglaja nana may be distinguished from the other six by its pale, almost nondescript coloration and by the characteristics of its shell, taken in combination. It is nearly completely calcified but thin and with a solute spire and is lacking a projecting process at the right posterior margin. It is markedly different in coloration from the only other two species of Aglaja which we have collected or examined from the Central California coast, namely: A. diomedea, which is brownish-black and which often occurs in pools near high tide level on the mud flats south of Dillon Beach, Marin Co., at the entrance to Tomales Bay; and A. ocelligera (Bergh, 1894), which is black with blue dots and which has been taken on the mud flats at Bodega Harbor, Sonoma Co.

Acknowledgements.--The authors are indebted to Dr. Cadet Hand, of the Department of Zoology, University of California, Berkeley, for his generous assistance in the preparation of this paper, and to Mrs. Emily Reid, Department Illustrator for Botany and Zoology, for the preparation of the figures.

LITERATURE CITED.

- Bergh, R.
1894. Die Opisthobranchien.
From Reports on the dredging operations off the West Coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U. S. Fish Commission Steamer "Albatross", during 1891. Bull. Mus. Comp. Zool. Harvard, 25: 125-233, 12 pl.
- Hand, C., and J. Steinberg
1955. On the occurrence of the nudibranch Alderia modesta (Loven, 1844) on the Central California Coast. Nautilus 69 (1): 22-28, figs. 1-4.
- Jones, M. L.
1954. The Richmond Shoreline Survey. State of California, Department of Public Health. Report of the Department of Fish and Game. 40 (2): 105-121, 1 fig.
- MacFarland, F. M.
1924. Opisthobranchiate Mollusca. From Expedition of the California Academy of Sciences to the Gulf of California in 1921. Proc. Cal. Acad. Sci. XIII(25): 389-414, pl. 10-12.
- Tryon, G. W., and H. A. Pilsbry
1895-96. Manual of Conchology, Structural and Systematic. XVI: vii + 262 pp., 74 pl.

THE TYPE SPECIES OF LEPIDOPLEURUS LEACH IN RISSO, 1826

by

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(Plate 17)

The chiton genus Lepidopleurus Leach in Risso, 1826, is based on Chiton cajetanus Poli, 1791, as its type species by subsequent selection of J. E. Gray in 1847. It is a Mediterranean species with rather rough sculpture, as the accompanying

illustrations show. It is quite unlike the smoother beautifully-beaded representatives of the genus found on the West Coast of North America from Alaska at least to Scammon's Lagoon, Baja California. Our West Coast species are allocated

by some to the genus Leptochiton Gray, 1847, of which the type species is Chiton cinereus Montagu, 1803, (equal to Chiton asellus Spengler, 1797, but not to the older Chiton cinereus of Linnaeus, 1767) as subsequently selected by Gray in 1847. Chiton asellus Spengler comes from Norway, Iceland, and Greenland and has sculptural characters generally like our West Coast species. For purposes of systematic arrangement, Leptochiton is here considered to be a subgenus of Lepidopleurus as the two groups of species are closely related.

If the above appears to some as a complicated example of molluscan systematics, it can also be pointed out that there is another later genus Lepidopleurus of Carpenter in Dall, 1879 (not of Leach in Risso, 1826). The type species of this Lepidopleurus is Chiton mertensi Middendorff, 1846, which is a medium-sized reddish chiton found commonly under rocks along the coast from central California to Sitka, Alaska. As only one species, mertensi, was assigned to this Lepidopleurus by Carpenter (in manuscript) and published by Dall in 1879, it becomes the type species by monotypy. Because Carpenter's Lepidopleurus is preceded by that of Risso, it cannot be used under the Rules of Zoological Nomenclature. However, its type species, mertensi, was chosen by original designation as the type species of Lepidozona Pilsbry,

1892, which is now considered to be a good genus in its own right, although originally considered by Pilsbry to have only sectional rank below that of subgenus. Thus Lepidopleurus Carpenter in Dall, 1879, becomes a senior objective synonym of Lepidozona, as both have the same type species and the later Lepidopleurus is superseded by the older one of Risso.

The accompanying photographic illustrations by Mr. E. C. Crompton of the California Academy of Sciences are made from specimens of Lepidopleurus cajetanus (Poli) in the U. S. National Museum kindly loaned for study by its Curator of the Division of Mollusks, Dr. Harald A. Rehder.

SELECTED REFERENCES.

re: Lepidopleurus Leach in Risso.

Bergenhayn, J. R. M.

1955. Die fossilen Schwedischen Loricaten nebst einer vorläufigen Revision des Systems der ganzen Klasse Loricata. Lunds Univ. Årsskrift, N. F., Avd. 2, Bd. 51, Nr. 8, p. 40.

Dall, William Healey

1879. Report on the limpets and chitons of the Alaskan and Arctic regions, with descriptions of genera and species believed to be new. Proc. U. S. National Mus., 1:314.

Fig. 1. Lepidopleurus cajetanus (Poli). Dorsal view, USNM No. 177289. From Cape Breton, France (Jeffreys Collection). Fig. 2. Same, side view. Fig. 3. L. cajetanus (Poli). Dorsal view of USNM No. 306083 from Guetaria, Bay of Biscay, Spain (Henderson Collection), with valve v removed. Fig. 4. Same, side view. Fig. 5. Same. Ventral view of valve v showing the short, triangular sutural laminae with wide sinus between and the degenerate, unslit insertion plates characteristic of this species and of others in the family Lepidopleuridae.

(Figures 1-4 enlarged about X 2; figure 5 about X 4.)



Figure 1

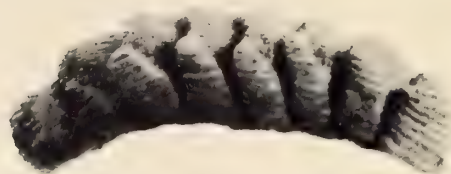


Figure 2



Figure 4



Figure 3

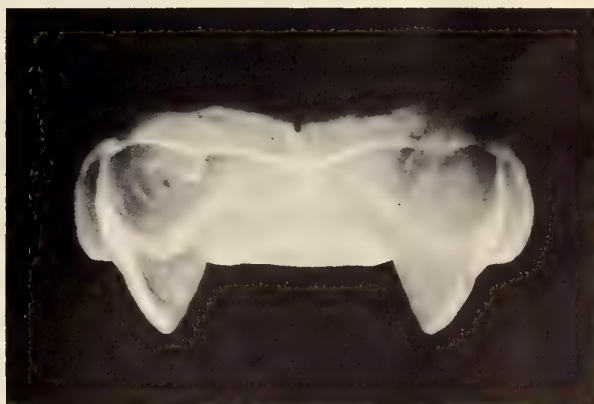


Figure 5

- Dall, William Healey
 1894. A new chiton from California. *Nautilus* 8(8): 90-91.
 1918. Notes on the genus *Trachydermon* Carpenter. *Nautilus*, 32(1): 1-3.
- Gray, John Edward
 1847. A list of the genera of Recent Mollusca, their synonyma and types. *Proc. Zool. Soc.* (London), p. 168.
- Hoffman, H. (in Bronn, H. G.)
 1930. Die Klassen und Ordnungen des Thierreichs, wissenschaftlich dargestellt in Word und Bild, 3(1): 375.
- Leach, W. E. (in Risso, A.)
 1826. Histoire Naturelle des principales productions de l'Europe Meridionale, 4:267-271.
- Pilsbry, Henry A.
 1892. Manual of Conchology, 14: 1-3.
- Taki, Isao & Taki, Iwao
 1929. Notes on Japanese chitons. *The Venus*, 1(5): 157-164.
- Thiele, Johannes
 1931. Handbuch der Weichtierkunde. 1(1): 6-7.
- re: *Lepidopleurus* Carpenter in Dall.
- Dall, William Healey
 1879. loc. cit., p. 297.
- Pilsbry, Henry A.
 1893. Manual of Conchology, 14: 86, 125.

A METHOD FOR THE STUDY OF THE WATER CURRENTS OF INVERTEBRATE
 CILIARY FILTER FEEDERS

by

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The problem of measuring the pumping rate of a ciliary filter-feeding organism has no completely adequate solution at present. The best methods so far developed are limited to a few specialized groups of filter-feeders, and no method offers a precise determination of absolute instantaneous rate of flow.

The study of flow rates can be pursued by two broad categories of methods: those that do and those that do not require contact between apparatus and animal. Bidder (1923) describes a simple method of the second type for measuring the velocity of the excurrent jet of an osculate sponge. A carmine suspension is delivered to the ostia by a hand pipette. Then, in Bidder's words:

I found the coloured jet marked by dark beads or nodes, caused by my pulse shaking the pipette; the length between any two nodes, divided by three-quarters of a second, gives the core-velocity at that part of the jet.

The analysis of various sponge currents by this method led to an empirical formula:

$$L = (12 \pm 2) VB (1 - 0.023[20 - t])$$

cm., sec. °C.

L = Length of jet. B = diameter of jet at osculum. V = Velocity of jet. t = temperature.

.....

The value of Bidder's work is reduced by a single unfortunate circumstance. In accord with the style of many papers of that time, he reports conclusions primarily, and includes little of the supporting data. Although he spent six years at the Naples Zoological Station and observed over a thousand individuals, his calculations are illustrated by figures drawn from a single sponge (number A-11). Jørgensen (1955) calls Bidder's paper the only reliable determination of the work done by the ciliary pumping mechanism of a filter-feeder. Yet the range of variation and the mathematical reliability of Bidder's results cannot be obtained from his report.

Other methods involving no physical contact with the organism are the particle removal method and the vane method. The particle removal method dates from Dodgson (1928) who determined the rate of clearing of mud suspensions. Jørgensen (1949b) further developed the method of Fox, Sverdrup, and Cunningham (1937) using dyes, graphite suspensions, and algae. Chipman and Hopkins (1954) determined the rate of clearance of radioactive algal suspensions by *Pecten*. Their work represents the best short term measurement made by the particle removal method.

Regardless of the material used or the methods of determining its concentration, there are several problems associated with this technique. MacGinitie (1941) and Jørgensen (1949a) have demonstrated relationships between particle concentration and feeding rate. It appears probable that all filter-feeders require some method of sensing particle density, and that feeding rates and methods are affected by the number and kinds of particles in the water. If the animal can sense the change in particle concentration used to

measure its pumping rate, it may alter that rate during the course of the experiment to match each new particle density. The problems encountered in creating stable, non-toxic, monodisperse suspensions of known particle size complicate the comparison of separate experiments.

The vane method of Hopkins (1933) uses a conical cup suspended in the excurrent stream. Deflections of the cup caused by variations in the stream are registered on a kymograph. Hopkins points out that this method is limited to the comparison of flow rates and is incapable of determining absolute amounts.

Of the various techniques which involve apparatus directly attached to the animal, the apron technique is probably the least disturbing to normal behaviour. The use of an apron, an impermeable membrane separating the incurrent and excurrent openings, was originally suggested by Moore (1910). The separation of the two openings permits water pumped through the animal to be isolated, collected, and measured. The apparatus was improved by Loosanoff, Engle, Galtsoff, and other workers. The most elaborate apron measuring device is found in Loosanoff and Engle (1947). The apron is limited in application to shelled forms whose incurrent and excurrent orifices are widely and distinctly separated. The associated equipment is elaborate and cumbersome, and while in theory it produces no pressure differential, in practice overflow back pressure cannot be reduced to zero.

Most filter-feeding organisms offer the possibility of isolating either the incurrent or excurrent flow in a tube attached directly to the animal. The rates of flow of such isolated streams have been

determined by a variety of methods. The technique of Wells and Dales (1951), developed for polychaete tube dwellers, has been applied to a ciliary filter-feeder by Hoyle (1953). This method depends on the creation of a back pressure. A continuous record can be obtained, but the resistance of the back pressure may account for the rather low values of Hoyle's measurements. Hoyle includes in his paper a criticism of Hecht (1916), who measured the speed of carmine particles fed through a glass incurrent cannula. Hoyle's own drop migration method (1953) and Galtsoff's carmine method (1926) share certain difficulties with the method of Hecht. Any cannulation procedure involves continuous contact stimulation of the animal, and the restricted bore of the cannula creates a viscous resistance not experienced in nature. Galtsoff has introduced several other cannulation methods, all of which involve severe handling of the animal. His usual procedure is to prop apart the shells of an oyster with a glass rod and to pack cotton around the edges of an inserted tube. Leaks are detected with carmine, but disturbances of the animal are not measurable.

It would be desirable to find a method of measuring instantaneous flow rate in ciliary filter-feeders which did not depend on handling the animal or on modifying its environment beyond the limits found in nature.

This paper presents an attempt to develop such a method. The work done is in a large part the product of the patient encouragement and criticism of Dr. Ralph I. Smith, and of many discussions with other members of the Zoology Department of the University of California at Berkeley, in particular, Professor Jonas Gullberg and Gordon W. Ellis.

Qualitative Observations Using the Streaming Birefringence of Tobacco Mosaic Virus

When large molecules with a high degree of axial asymmetry are aligned in solution they exhibit anisotropy. Molecular alignment can be created by movements of the solution. The degree of anisotropy is a function of the size of the particles, their shape, and concentration, and the rate of flow of the stream of solution. This effect, called streaming birefringence, can be used to demonstrate currents in a liquid.

A solution of 5 gram/liter of Tobacco Mosaic Virus (the TMV used was a supernatant from the centrifugal purification of infective virus, supplied through the courtesy of Dr. C. A. Knight of the Biochemistry and Virus Laboratory, University of California, Berkeley) in sea water gives a usable visualization of the excurrent streams of small *Mya arenaria* (L.). A 5 x 5 x 20 cm. aquarium filled with the solution was placed between two crossed sheets of Polaroid HN32 linear polarizer. On one side of the aquarium a Leica 35 mm. camera, stopped to f4, was focussed on the test animal. On the other side a pair of lights was set up behind a ground glass screen. One bulb was red filtered and provided the normal viewing light. The other was a Braun "Hobby" photographic flash which gave enough light to expose Kodak Tri-X film for optimum development in D76. A clam, relaxed and pumping in the tank, created a birefringent area extending from the excurrent opening. Several attempts were made to measure the rate of this excurrent stream. The only method that met with even partial success was an attempt to emulate Bidder by mechanically injecting drops of virus-free sea water into the moving stream. It was hoped that the drops would stand out as black areas in the

light stream, since they would lack the polarizing properties of the surrounding medium. The normal ciliary-propelled stream of *Mya* is smooth and laminar, easily distinguishable from the turbulent jet created by a muscular contraction of the body wall. Such a laminar stream slows down by picking up the surrounding water and accelerating it in the direction of the primary current. The birefringence of this secondary current is sufficient to mask all but the densest black spaces in the main stream. Drops sufficiently large to mark the stream were diffuse and hard to measure.

Although streaming birefringence did not prove practical as a quantitative tool, its advantages as a qualitative method of observation should not be ignored. The morphology of the excurrent stream, its laminar character, slow widening, and rapid decay are easily visible. The Tobacco Mosaic Virus is apparently not irritating to the clam. Frequent filtration, occasional centrifugal purification, and a few milliliters of penicillin-streptomycin solution will preserve a half liter of the dilute virus for several months. In all of the experiments apparatus and animals were maintained at 15°C.

Photographic Determination of Water Movement

A multiple photographic exposure of a scene in which some objects move and others are motionless will permit measurement of the existing rates of motion. By fixing the time intervals between individual exposures the time required for a particle to move from one position to the next can be determined, and the distance moved can be calculated from the distance recorded on the photographic negative. The camera used in the previous

experiments was modified to permit multiple exposures by the addition of a second rotating shutter in front of the lens. The shutter was a six inch disk, driven by a geared synchronous motor at 66 rpm, with segments cut from its edge to generate the desired exposure sequence. The camera's own focal plane shutter was held open for one or more revolutions of the multiple shutter, and the film recorded a series of exposures whose time relationships were accurately known.

A thin aquarium (7 x 25 x 40 cm.) was filled with a suspension of aluminum dust in sea water. The moving dust grains could be photographed by the modified camera as rows of dots. The dust is "Albron" powder, a standard paint pigment sold by Alcoa. Suspensions made by shaking a few grams of powder in a small volume of sea water, and diluting to the required concentration, are stable for several hours. Individual particles range from 1/10 to 1/100 mm. in greatest dimension, but the thickness of the sheetlike fragments is on the order of 1/1000 mm. Particle concentrations as low as twenty per cubic centimeter can be used. Such suspensions appear perfectly clear unless illuminated by an intense beam of parallel light which reveals the aluminum grains as smoke particles are revealed by a shaft of sunlight.

The aquarium was lighted from above at right angles to the line of sight of the camera. A microscope lamp with a 6 cm. lens, focussed to a parallel beam, was intense enough to allow the light reflected by the particles to be photographed. To increase the visibility of the particles, the aquarium was backed with dull black paper.

A size scale was made by blackening alternate squares of a one

inch square of one tenth inch ruled graph paper. In use the scale was placed on the wall of the aquarium behind the experimental animal. The checkerboard pattern was used to allow the scale to be reconstructed from a slightly out-of-focus view. Since the animal was nineteen inches from the camera, the maximum apparent reduction of the size scale was 5%, or about equal to the error created by estimating the boundaries of squares in the photograph.

An animal under test was positioned so that both siphon openings presented clear profiles to the camera. The areas of the circular openings were calculated from their measured diameters. A single picture taken under these conditions gives a velocity diagram of the water in the tank. Convection currents must be avoided, since they warp the paths of the particles from the pattern created by the animal.

If we assume the volume of the animal to be constant during the time of exposure, the product of incurrent velocity and the area of the incurrent siphon must be equal to the product of excurrent velocity and area. The two streams behave in different fashions, and the differences must be understood before the velocities at points distant from the animal can be extrapolated to the siphon tip.

The incurrent water moves in a very simple pattern. Consider an isolated incurrent siphon. Near the siphon opening a small volume of water moves to enter the animal. A shell of water surrounding this volume moves in to occupy the space left by its removal, another shell moves in to occupy the new vacancy, and so on outward. It is obvious that the shells will enlarge their areas and decrease their thicknesses with increasing distance from the siphon tip, since the volume of

the shells is constant and each must inclose its predecessor. In fact, the shell thickness, which is equivalent to the linear rate of water movement, will vary inversely as the square of the distance from the siphon tip.

The excurrent water disturbs this regular motion, since, as was seen in the Tobacco Mosaic Virus studies, it loses energy by accelerating the surrounding water. The inner portion of the excurrent stream remains at a nearly constant speed while the outer boundary is slowed by the surrounding incurrent water. The incurrent flow is actually reversed by contact with the outflow. Bidder's formula will not apply to such a situation, since the outgoing jet is opposed, not by still water, but by an actively moving stream.

Measurements of flow rate must be taken either at the center of the excurrent stream or at a considerable distance from it, in order to avoid the anomalous area where the two currents touch.

Reduced weight was determined by weighing the animal in a glass graduate filled to a constant level. Such a measurement offers a quick and reproducible way to characterize animals with a variable internal water space.

Ciliary flow in *Mya* shows occasional discontinuities of a regular form. The clam first opens its incurrent siphon and begins to create a current. This priming current is probably established by a relaxation of the adductors and a consequent increase in internal volume. Starting the flow in this way would relieve the cilia of the heavy burden of the initial accelerative load. After the incurrent flow is established, the excurrent siphon opens and begins to emit its jet. The excurrent jet rises to a maximum rate of flow and maintains activity for minutes or

hours at a time. It is not possible to isolate an animal from low frequency vibration in the building where this work was carried out. There is no evidence, therefore, of spontaneous rhythmicity in the time devoted to ciliary pumping. Either the excurrent flow, the incurrent flow, or both may stop abruptly, or the entire cycle may be interrupted by a muscular expulsion of water from one or both jets. Either cessation of flow or squirting may be induced by a disturbance such as a door slamming, an engine starting, or a sudden changing of illumination.

Although Platyodon has a much greater incurrent to excurrent area ratio than Mya, its pattern of ciliary currents is very similar. The muscular pumping is rather different and may reflect the needs of an animal that is unable to withdraw its siphon and relocate it inches away. The excurrent siphon of Platyodon is equipped with a translucent collar which functions as a valve. When placed in a heavy suspension of particles, Platyodon tends to expel sudden jets of water. After each jet the body expands, but the valve prevents water from re-entering the excurrent siphon. This arrangement may serve to allow the clam to increase the amount of water passing through its gills without altering the direction of flow.

A recent summary of filtering rate determinations is included in Ballantine and Morton (1956). Ranges of from 3.9 to 20 liters/hour are recorded for Ostrea virginica of a size comparable with that of the Platyodon cancellatus (Conrad) used in the present study. The animals are not strictly comparable, and the rate of 0.5 liters per hour determined for Platyodon can only be said to be of approximately the correct order of magni-

tude. The Mya values can be compared with the published values for Mytilus with the same reservation. Mytilus exhibits a range of from 1.1 to 1.9 liters/hour as compared with the present measurement of 0.25 liters/hour for Mya arenaria (Linn.).

The aluminum dust-photographic method of studying ciliary currents can be applied to any filter-feeder. Those organisms which possess irregular siphon openings may be analyzed by determining the area of the openings planimetrically from auxiliary photographs. The particle concentrations used compare favorably with the lowest particle densities found in nature. The animal is subjected to constant light and temperature conditions, no machinery is attached to the animal, and no resistance is offered to normal movement. The only specialized piece of apparatus, the rotating shutter, is easily constructed from inexpensive and readily available parts.

This technique allows an exact and simple determination of absolute instantaneous flow rates, and in addition permits the quantitative or qualitative study of flow patterns, their interaction with other currents, and their variation under environmental changes.

LITERATURE CITED.

- Ballantine, D., and Morton, J. E.
1956. Filtering, feeding and digestion in the lamellibranch Lasaea rubra. J. Mar. Biol. Ass., U. K., 35, 241-274.
- Bidder, G. P.
1923. The relation of the form of a sponge to its currents. Quart. J. Micro. Sci., 67, 293-323.
- Chipman, W. A., and Hopkins, J. G.
1954. Water filtration by the Bay Scallop, Pecten irradians, as observed with the use of

- radioactive plankton. Biol. Bull., Woods Hole, 107, 80-91.
- Dodgson, R. W.
1928. Report on mussel purification. Fish. Invest., Lond. ser. 1, 10.
- Fox, D. L., Sverdrup, H. N., and Cunningham, J. P.
1937. The rate of water propulsion by the California mussel. Biol. Bull., Woods Hole, 72, 417-438.
- Galtsoff, P. S.
1926. New methods to measure the rate of flow produced by the gills of oysters and other mollusca. Science, 63, 233-4.
- Hecht, S.
1916. The water current produced by Ascidia atra Lesueur. J. Exp. Zool. 20, 429-434.
- Hoyle, G.
1953. Spontaneous squirting of an ascidian, Phallusia mammillata Cuvier. J. Mar. Biol. Ass. U. K. 31, 541-562.
- Jørgensen, C. B.
1949a. The rate of feeding by Mytilus in different kinds of suspension. J. Mar. Biol. Ass. U. K. 28, 333-344.
- 1949b. Feeding rates of sponges, lamellibranchs, and ascidians. Nature, Lond., 163, 912.
1955. Quantitative aspects of filter-feeding in invertebrates. Biological Reviews, 30, 391-454.
- Loosanoff, V. L., and Engle, J. B.
1947. Effect on different concentrations of micro-organisms on the feeding of oysters (O. virginica). Bull. U. S. Fish and Wildlife Serv. 51, 31-57.
- MacGinitie, G. E.
1941. On the method of feeding of four pelecypods. Biol. Bull., Woods Hole, 80, 18-25.
- Moore, H. F.
1910. Volumetric studies of the food and feeding of oysters. Bull. U. S. Bur. Fish, 28, 1295-1308.
- Wells, G. P., and Dales, H. F.
1951. Spontaneous activity patterns in animal behaviour: The irrigation of the burrow in the polychaetes Chaetopterus variopedatus Renier and Nereis diversicolor. O. F. Muller. J. Mar. Biol. Ass. U. K. 29, 661-680.

COLOR PHASES IN MONADENIA FIDELIS (GRAY)

by
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Willow Creek, California
(Plate 18)

While making a comparative study of the populations of the large land snails inhabiting the Klamath Mountains in extreme northern California, some rather interesting distributional patterns were noted. The project chiefly concerned the distribution and speciation in the genus Monadenia Pilsbry, and as a matter of course special attention

was given to coloration and color pattern. Usually, it was noted that a species or race inhabited a specific drainage area; from the glacial cirques that headed such an area, to the downstream junction with some major watercourse. Therefore it afforded some interest when a rather distinctive sequence of color phases was found that

utilized a rapid stream for a barrier as well as a means of distribution along the lower courses.

No attempt is made to designate taxonomic changes, as all specimens gave evidence of belonging to a single species as well as race. They will be only referred to as Monadenia fidelis (Gray) s. l.

The area under study covers the lower Trinity River from the junction of the Klamath and the Trinity Rivers, upstream (south) for approximately forty-five miles to the southern known limit of the distribution of this population of Monadenia fidelis. The South Fork of the Trinity River, the major tributary, forms the western branch of the basic river, and branches westward about midway on a north and south axis. As far as could be determined, the geology, weather, and botany of the area is so similar that for all purposes it may be called the same.

In checking over the series of specimens available, it was noted that the ventral surface of the snails was a rich, polished, chocolate brown in all cases. It was only on the dorsal surfaces that the distinctive color patterns were observed. For convenience these are listed as follows:

PHASE "A":

This may be referred to as the "multibanded" phase. The dorsal surface is a greenish yellow, dull, with a dark thin band at the suture. A wide dark band is present at the periphery or just above, which in turn is centered with a thin yellow or tan line. There is an intermediate light brown line, between the peripheral banding and the suture, which at times is quite strong, and at other times so faint as to be almost obsolete.

PHASE "B":

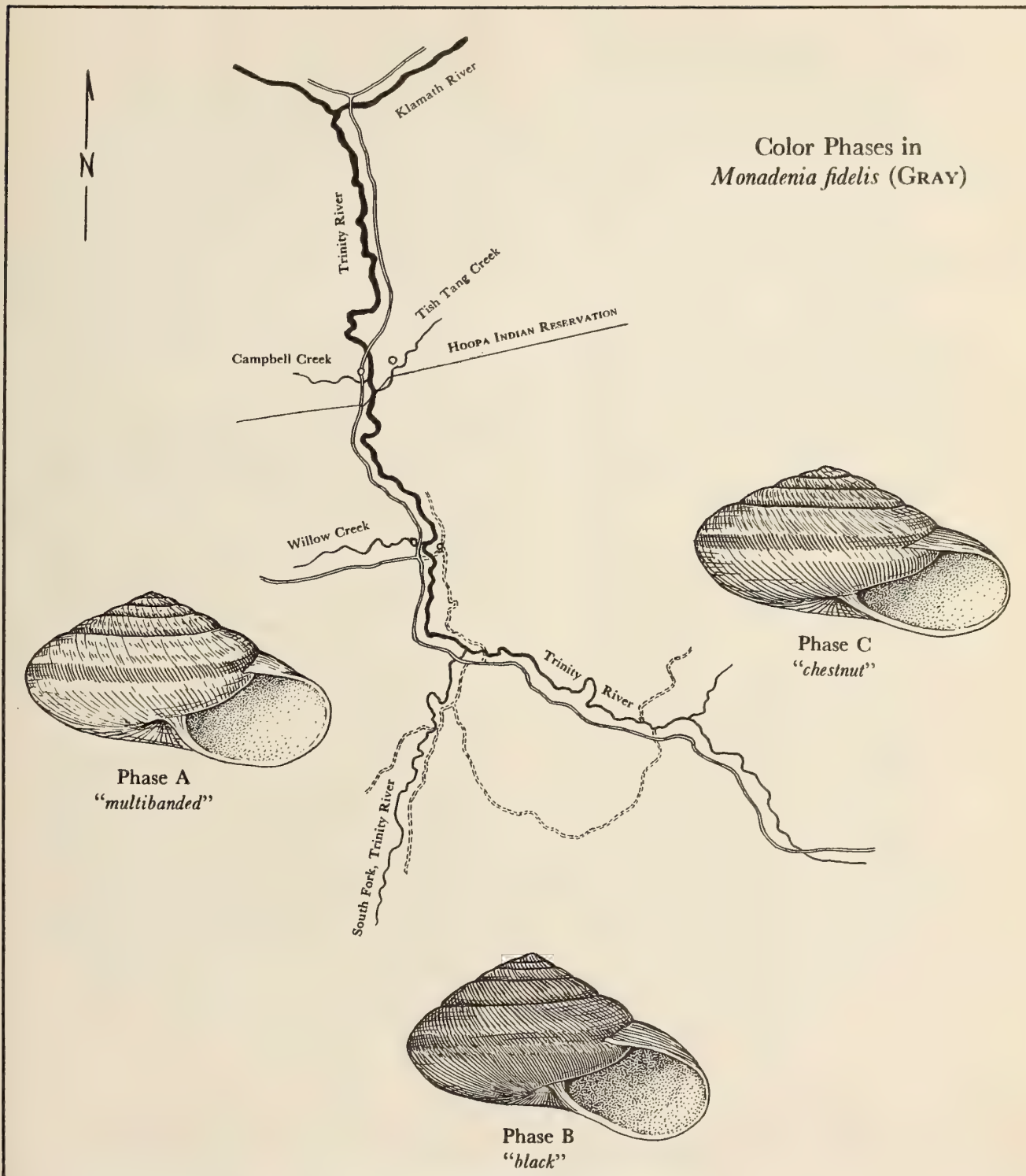
For convenience this is referred to as the "Black" phase. Dorsally the shell is a dull blackish brown. The wide peripheral band merges into both the dorsal and ventral dark colorations, and the thin central line on the periphery is a dull reddish brown, at times obsolete.

PHASE "C":

"Chestnut" may be used to designate the third color pattern. This is similar to phase "B", but is distinguished by a rich chestnut area on the dorsal surface, offset only by a rather blurred dark area at the suture.

Each of these color phases occupies a distinctive portion of the region, and is in contact with adjacent phases along the rivers. For some reason or other, indications seem to be that there is extremely little mixture of the phases. This is especially true upstream from the junction of the Trinity River and the South Fork of the Trinity River. A single specimen referable to phase "A" has been found on the banks within the area occupied by phase "B". None of the "Blacks" have been located within the range of the "multibanded" so far. Two examples of the "Chestnut" or "C" phase have been found on the west side of the Trinity River within the range of "B". A careful search has been made along both shores for such, as this strong a separation is extremely unusual.

Downstream from the junction of the two rivers, there is a gradual, but still rather rare, mingling of the phases, with some specimens showing degrees of intergradation between two or more color types. The first populations worked were



along the Trinity River, where Willow Creek, a small tributary, enters the river. A series from the west side of the river, consisting of twenty specimens, showed that the "A" phase was represented by ten, phase "B" by none, phase "C" by four; the other six were mixed in coloration. Another series of twenty-five, from the east side of the river at the same location, gave phase "C" a total of ten, phase "B" a total of five, phase "A" two, with the remaining eight again mixed in coloration.

Fifteen miles further downstream two populations were compared, Campbell Creek on the west side of the Trinity River and Tish Tang Creek on the east side. At Campbell Creek, the "multibanded" comprised five of the ten specimens examined, the rest were intermediate. At Tish Tang, six out of fifteen were "Chestnut", the rest a mixed series of intermediate color forms.

Due to lack of facilities, the higher elevations were not worked over as much as the downstream area. Specimens were taken where and when found, but in such small numbers that a definite sequence of phase distribution was impossible to establish. However, even with the lack of material, the few specimens that have been collected indicate that the intergradation between phases is only along the river, as the higher

elevation material once again indicates almost a pure population. It was noted that phase "C" appeared to be lighter in coloration near the junction of the Trinity and Klamath Rivers, which possibly could be attributed to the influence of some of the lighter, polished specimens of the Klamath River.

Thus it appears, at least in Monadenia fidelis, that the rapidly moving rivers in the western Klamath Mountains create barriers between snail populations. It is also quite possible, and probable, that high waters such as the floods of 1955-56 may carry snails and deposit them in the debris downstream. There in turn, they may establish populations intergrading with the basic phase or group native to the area. On the other hand, there may be certain conditions unknown to the writer that will prevent the establishment of such a drift population. A case in point appears to be an observation on another species of the genus, Monadenia setosa Talmadge. A small population was found that could only have been carried by flood debris twenty miles downstream from the most northern locality known. This small colony existed for only one year, and at the present time, no trace of specimens in the drift nor on the slopes along the river can be found.

THE CARNIVOROUS HABIT AMONG THE POLYPLACOPHORA

by

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(Plate 19)

The feeding habits of chitons are usually dismissed with the statement that nearly all are herbivorous. The studies of Heath (1903) and Simroth and Hoffman (1929), the best known

reports of the feeding habits of chitons, are probably the basis for most of those statements. Heath observed Cryptochiton stelleri (Middendorff) feeding on algae. Simroth and Hoff-

man state that the majority of chitons are herbivorous and that the one reported case of a carnivorous chiton was in need of further study. This implied exceptional case was one by Plate (1901) who found Hanleya hanleyi (Bean) dredged from a depth of 500 fathoms containing many spicules and fragments of the sponge Geodia. Von Siegfried (1954) has stated that "Hanleya abyssorum (M. Sars) ist schwammfresser".

It would be easy to believe that groups of animals living in ecologically similar environments might have similar feeding habits. One most often finds chitons in the rocky littoral zones where there is an abundance of plant material. In reality the Polyplacophora are a widely distributed group of animals ranging from rocky shores to mud bottoms in the abyssal depths where they are found clinging to shells and other hard materials. Taki (1939) reports that Lepidopleurus benthus (Haddon) has been dredged from 2300 fathoms in the Pacific, 2200 fathoms below

the euphotic zone. It is difficult to conceive of animals living at those depths feeding on anything but animal matter, or at least on detritus, since any plant material drifting down from the euphotic zone should have disintegrated or been eaten long before reaching the bottom. Thus, it seems reasonable to assume that not all chitons are herbivorous, but that a number of them must be living on something other than plant matter.

A study of the gut contents of several species of chitons in the genus Mopalia has revealed some differences in feeding habits which tend to support the view that some species of this genus are more carnivorous in habit than others.

This is a report of the examination of 400 specimens of chitons collected from the shoreline of the San Francisco Bay where 5 species of the genus Mopalia occur. The species are Mopalia hindsi (Reeve, 1846), M. muscosa (Gould, 1846), M. c. ciliata (Sowerby, 1840), M. lignosa (Gould, 1846), M. porifera Pilsbry, 1892, and

EXPLANATION OF ABBREVIATIONS IN PLATE 19

Figure 1: Mopalia muscosa (Gould) (based on 110 specimens)

Misc. = Barnacles, hydroids, bryozoans. Amorph. = Amorphous material not identifiable as plant or animal. S.-M. = Sand and mud. Algae = Algae other than those identified in other sectors. Ulva = Ulva-like algae.

G. A. = Green colored algae.

Figure 2: Mopalia c. ciliata (Sowerby) (based on 34 specimens)

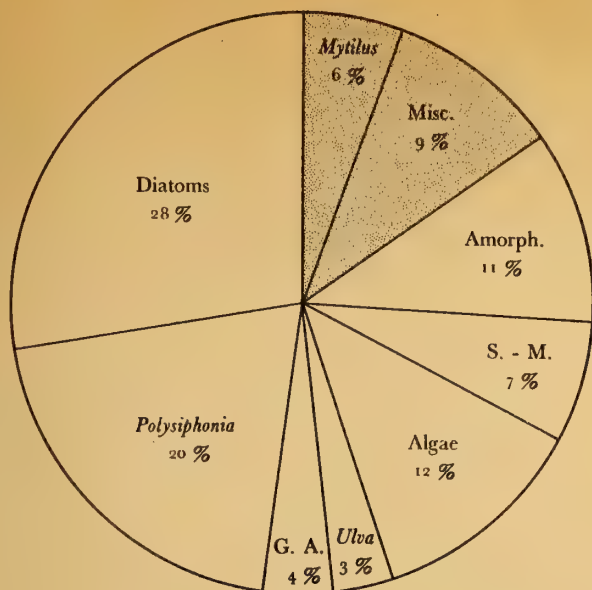
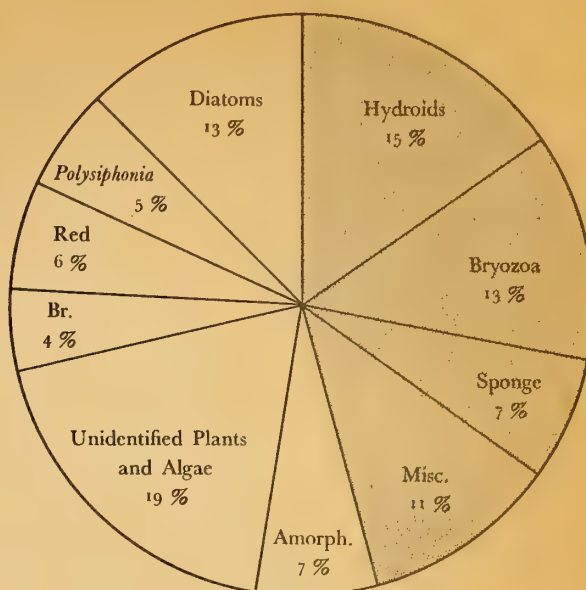
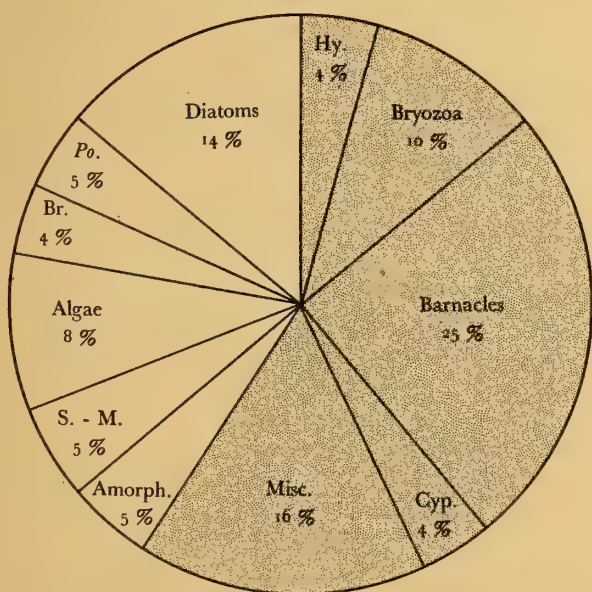
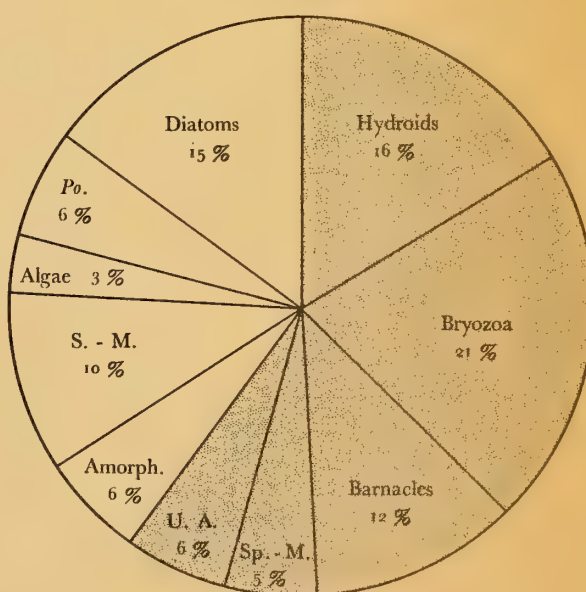
Misc. = Mollusks, barnacles, annelids. Amorph. = Amorphous material not identifiable as plant or animal. Br. = Brown colored algae. Red = Reddish colored algae.

Figure 3: Mopalia hindsi (Reeve) (based on 242 specimens)

Hy. = Hydroids. Cyp. = Cyprid Larvae. Misc. = Sponge, annelids, crustaceans, mollusks. Amorph. = Amorphous matter not identifiable as plant or animal. S.-M. = Sand and mud. Algae = Algae other than those identified in other sectors. Br. = Brown colored algae. Po. = Polysiphonia.

Figure 4: A variety of Mopalia hindsi (based on 29 specimens)

Sp.-M. = Sponge and mollusks. Unid. An. = Unidentified animal matter. Amorph. = Amorphous matter not identifiable as plant or animal. S.-M. = Sand and mud. Algae = Algae other than those identified in other sectors. Po. = Polysiphonia.

Figure 1. *Mopalía muscosa* (Gould)Figure 2. *Mopalía c. ciliata* (Sowerby)Figure 3. *Mopalía hindsi* (Reeve)Figure 4. A variety of *Mopalía hindsi* (Reeve)

Proportions of Various Materials Found in the Gut of Some Species of the Genus *Mopalía* in San Francisco Bay
February 1952 to June 1953. Shaded Areas Indicate Animal Material.

a variety of M. hindsii which is probably a subspecies. These species were found to vary in their distribution in the San Francisco Bay in zones which could be correlated with the amount of variation in salinity. The animals were also limited in their distribution to the cooler portions of the Bay (Barnawell, 1954).

Mopalia hindsii is the most common and most widespread chiton in the Bay. It ranges from the mouth of the Bay to the back reaches, and from the tops of surf-swept rocks to the quiet waters under piers and behind breakwaters. In addition, M. hindsii is able to tolerate as great a reduction in salinity as 15% of normal sea water.

Mopalia muscosa is the next most common species but is distributed more irregularly. It is frequently found in the more euryhaline areas of the Bay, some of which have Polysiphonia as a prominent plant constituent. These areas must constitute a particularly difficult environment for marine animals since they are often subjected to drastic reduction of salinity, and the water is frequently quite muddy. Mopalia c. ciliata and a variety of M. hindsii comprise less than 20% of the total chiton population and are confined to a narrow zone surrounding the mouth of the Bay. The variety of M. hindsii has not been found outside the Bay; however, M. c. ciliata is quite plentiful on the open coast.

Mopalia lignosa and M. porifera occur only rarely within the Bay. It should be noted that the radulae of all these species are almost identical and are large and massive enough to rasp entire living barnacles along with their shells from their places of attachment.

METHOD.

The gut contents of all the animals collected in this study (over 400 in number) were examined and the

constituents were identified to species when possible. A rough subjective estimate was made of the percentage of each item making up the total volume of the gut contents. The data thus obtained were pooled for each species and are summarized in Plate 19, Figures 1-4.

RESULTS.

The gut contents of Mopalia muscosa (Fig. 1) averaged about 15 per cent animal matter. Juvenile Mytilus was the most frequently occurring animal matter though making up only a little over 5% of the total gut content. Since M. muscosa occurs frequently in the back reaches of the Bay, in areas in which the most prominent plant is Polysiphonia, it is not surprising to find a high percentage of that algae in the gut contents. Diatoms are tremendously abundant in San Francisco Bay, frequently accumulating in masses easily visible to the casual observer. The gut contents of M. muscosa reflect, to some extent, the environment in which this species lives, although they do possess a gustatory organ which should enable them to select their food.

In Mopalia c. ciliata (Fig. 2) animal matter makes up more than 45 per cent of the total gut contents, with hydroids and bryozoans figuring most prominently. The amount of sponge is particularly interesting, for, if the animal contained any sponge at all, there was usually a high proportion. Two specimens were found in the center of a patch of bare rock completely surrounded by an encrusting sponge, and their digestive tracts were so filled with sponge spicules as to be gritty to the touch.

Fifty-nine per cent of the score in Mopalia hindsii (Fig. 3) is made up of animal material, nearly half of that being barnacles. Mopalia hindsii is more common than the other species. It was possible, therefore, to analyze the data further. For instance, a breakdown by months reveals that

this species turns to a greater proportion of animal food in the months of May through December. It may be significant that the Bay is less subject to extremes in salinity variation during that drier part of the year. There was approximately 63 per cent animal matter in the gut of animals collected in May through December in contrast to only 52 per cent in the animals collected from January through April. Further, animals living close to the mouth of the Bay and therefore less subject to extreme reductions in salinity have a greater preponderance of animal food in their gut than those living in the back reaches of the Bay. Younger animals also seem to take in a greater proportion of animal matter than the older ones.

The gut contents of the variety of *Mopalia hindsii* (Fig. 4) show almost the same proportion of animals to plant food as the parent species, but a difference in kinds of animals taken. In the varietal form bryozoans are the most plentiful item in the gut with hydroids holding an important position, barnacles are much less prominent than in the parent species.

SUMMARY AND DISCUSSION.

The feeding habits of the species of the genus *Mopalia* may be summarized as follows:

<i>M. muscosa</i> takes in	15%	animal	food.
<i>M. c. ciliata</i>	45%	"	"
<i>M. hindsii</i>	59%	"	"
<i>M. hindsii</i> variety	59%	"	"

Within the genus *Mopalia* there can be variation in feeding from almost entirely herbivorous habits to species which take in a majority of animal foods. With this much variation

in a single genus, it would not be surprising to find that there is a great deal of variation among the chitons as a whole as regards food habits. One might even find some species which are completely carnivorous. This is probable in view of the fact that some species live in the abyssal depths where there is little, if any, plant matter available.

ACKNOWLEDGEMENT.

The author wishes to express his thanks to Dr. Cadet Hand for helpful suggestions in preparing this manuscript.

LITERATURE CITED.

- Barnawell, E. B.
1954. The biology of the genus *Mopalia* in San Francisco Bay. M. A. Thesis, Univ. of Calif., Berkeley.
- Heath, H.
1903. The function of the chiton subradular organ. *Anat. Anz.*, 23: 92-95.
- Plate, L.
1901. Die Anatomie u. Phylogenie der Chitonen. *Zool. Jahrb.* Suppl. V.
- Simroth, H., and H. Hoffman
1929. Polyplacophora. in Bronn's Klassen u. Ordnungen des Tierreichs. 3(Sect. 1): 129-368.
- Taki, I.
1939. Chitons in the Pacific Ocean. *Proc. 6th Pac. Sci. Congress*, 3: 487-491.
- von Siegfried, G. A. Jaeckel, Jun.
1954. Aculifera Aplacophora u. Aculifera Placophora im Gebiet der Nord- und Ostsee. *Kieler Meeresforsch.*, 10: 261-271.

ON THE PAUCITY OF INTERTIDAL BARNACLES IN THE TROPICAL WESTERN PACIFIC

by

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(Plates 20 and 21)

Barnacles or cirripedes are familiar organisms to nearly all who frequent the shores of temperate waters. So abundant are they that one tends to consider them common intertidal animals. In the preface to his monograph on the American sessile barnacles, H. A. Pilsbry (1916) speaks of them as one of the dominant groups of littoral animals. Indeed, it has been said that the present period may go down in the fossil record as the age of barnacles. This may be true in temperate waters but it is certainly not true of the tropics.

The California coast supports about six genera and twenty-five or so species of barnacles. Only a few of these species account for the abundance of intertidal individuals. On the other hand, nearly 250 species of barnacles are recorded from the Indo-Pacific. At least half this number are littoral and intertidal forms. However, although there are many different kinds, actual numbers of individuals are astonishingly small. This was perhaps first recognized by Darwin (1851-54) who pointed out that, for some reason, coral reefs are apparently unfavorable for barnacles. It is the purpose of this note to present some evidence as to why this should be the case for intertidal forms.

The principal collections and observations made in conjunction with this study were at Truk in the Caroline Islands. Supplementary work was done at Majuro in the Marshall Islands and at Guam in the Mariana Islands. Evidence contributed by others from different localities is cited in the text. In nearly all cases, corals or the littoral lime-

stones produced by them are prominent features of the situations under consideration.

The physical conditions under which reef-building corals flourish are well known. In general, they are restricted to the photic zone where surface waters are 21°C or warmer and they require clean, well oxygenated waters. Silty, poorly oxygenated, or diluted sea water is unfavorable for vigorous growth. In contrast, intertidal barnacles abound in cool temperate seas. Certain species flourish in turbid, and even stagnant, conditions, and some of the most luxuriant barnacle populations occur in estuaries, where seasonal dilution, variable temperatures, and turbidity are common.

We know under what conditions corals and barnacles grow abundantly, but there is little evidence as to why conditions other than these should be unfavorable. It is believed that physical conditions of the environment limit coral distribution, in that the number of species and the number of individuals or colonies become less as one moves away from tropical conditions. The number of barnacle species undergoes the same sort of decline as one moves away from the tropics. However, a paradox exists in that, although there are fewer temperate barnacle species, the relative number of individuals is great and they progress from an inconspicuous tropical element to one of the dominant temperate littoral forms. Thus, it would appear that barnacles are best adapted to temperate waters. It is not the exceedingly greater variety of barnacle species that exist in the tropics that encourages me to pursue this subject, but rather it is the fact that barnacles were occa-

sionally found in great profusion in certain natural and artificial situations in tropical waters. It is hoped that a consideration of these special situations and conditions will demonstrate that primarily biotic factors account for the relative paucity of intertidal barnacles in the tropical Pacific.

A clue to the nature of what limits barnacle abundance can be gained by a brief consideration of the types of habitats in which they occur. In general, there are three basic ones: some barnacles being found in or on fixed substrates, in or on other animals, and on inanimate objects floating in the sea. Although we are primarily concerned with the first of these, the others have indirect bearing on the overall problem.

In a relatively short time nearly any object that floats in the sea becomes covered with pedunculate barnacles. Specimens of Lepas spp. and Conchoderma virgatum were found washed up on reefs and beaches on pieces of pumice, cuttle bone, Nautilus shell, feathers, segments of Pandanus fruit, coconuts, and on glass fishing floats. The regular occurrence and abundance of these forms would indicate that although ocean and lagoon waters are highly transparent, they are not sterile but contain quantities of "barnacle forage". The habitat of the floating forms differs conspicuously from that of the littoral groups in that they are never associated with corals and are never uncovered by the tides.

In the temperate zone, one commonly finds sessile barnacles on littoral gastropod and bivalve mollusk shells and on large decapod crustacea. Generally, these barnacles are not particularly modified or specialized forms, but simply occur on the hard parts of other organisms occupying essentially the same level in the littoral zone. In cataloguing nearly 140 species of shelled mollusks in the tropics and handling probably ten

times this number of individuals, not a single epizoic barnacle was found. Decapod crustacea, on the other hand, are often infected with specialized pedunculate barnacles. Members of the genus Octolasmis were taken in the branchial chambers of the Mangrove crab, Scylla serrata (Forsk.) (1), the Slipper lobsters, Parabaccus antarcticus (Lund) (2), and Scyllarides squamosus (Milne-Edwards) (3). Another species of Octolasmis was found on the mouth parts of Scyllarides and another pedunculate, Heteralepas palinuri Barnard (1924), was taken from the mouth parts of the Spiny lobster, Panulirus penicillatus (Oliver) (2). All of these species have undergone a considerable degree of disarmament as compared with their free living counterparts, and this is clearly in response to the degree of protection afforded by their host. Octolasmis is of special interest for it occurs in such numbers as to suggest that physical conditions favor its existence; a factor contributing to its survival being the protection received from its host.

Barnacles found with corals are often specialized burrowing forms. One of the commonest coral burrowers is the fairly large pedunculate, Lithotrya. Another group, the order Acrothoracica, is composed entirely of burrowing forms, many of which inhabit corals. Among the sessile or acorn barnacles, Pyrgoma and Creusia burrow, or are buried, in living corals, and species of Balanus may occur with corals in situations where they receive mechanical protection from bends and folds in the coral skeletons. Since corals usually do not survive exposure to air during low tides, these barnacles are subtidal forms. They are rarely found with their shells fully exposed. The striking feature about the group is the protection it derives from corals and coral remains.

The pedunculate Ibla cumingi Darwin and the sessile genera Balanus,

.....

Chthamalus, and Tetraclita have true intertidal forms. These were never found on mollusk or crustacean hard parts. They tended to occur sparsely in interstices in or between and under rocks. Chthamalus occurred on high beach rock (1,2,4) covered only during high tides. Chthamalus was also found in fair numbers in brackish water areas and Mangrove swamps. Such areas are usually muddy and the barnacles grow on sticks, Mangrove prop-roots, and other solid substrates (1).

Other high intertidal areas were not found to support barnacles excepting in areas protected from wave action or where volcanic rock occurs. Coral limestone, unlike volcanic rock, is rather light in weight and smaller boulders are rolled around by wave action. This scouring probably accounts for the lack of barnacles along rubble ramparts. In general, then, the great reef-flat, the rubble rampart along reef islets, tide pools and the like, the entire intertidal zone between the lowest and highest reaches of the tides, is markedly deficient in numbers of barnacles. So sparse are they that they can be considered as relatively rare, inconspicuous intertidal organisms. What stark contrast to the shores of temperate waters!

In the subtidal, where corals abound, it is possible that the corals themselves or something about the coral association limits the numbers of barnacles. Competition between corals and barnacles for food would appear not to be a significant factor, for barnacles do occur with corals. In general, subtidal forms either exist under varying degrees of mechanical protection or are removed from the reef-building coral association. Yet it is apparently not the living corals that are entirely responsible for the lack of abundance, for in the intertidal, which is generally destitute of living corals, barnacles do not flourish either. Something besides corals, something outside of the strict coral association must be

unfavorable for intertidal forms.

The herbivorous fish that forage over the reef during high tides are of a very different sort than those that feed on sea weeds along our coasts. In contrast, they are provided with a variety of incisor-like teeth with which they rasp away at the limestone reef for the microscopic algae growing on its surface. In their rasping they remove substantial amounts of substrate. It would appear that their raspings may be responsible for an appreciable amount of erosion of limestone reefs. These fish are, in their manner of feeding, predators on such fixed organisms as barnacles, especially on freshly settled larval stages and young individuals. The Chaetodontidae (Plate 21, Figure 3c), Acanthuridae (Plate 21, Figure 3b), Labriidae (Plate 21, Figure 4b), Balistidae (Plate 21, Figure 4c), Diodontidae, and Tetradontidae represent some of the groups that have modified dentition enabling them to gnaw or rasp corals and limestones. Observations were made on various members of these groups. The acanthurids were perhaps the most abundant raspers this author noted on reef-flats at Truk, Guam, and Majuro. While lying face down in shallow water during rising tides and looking beneath the surface along the reef, one may see the dark shapes of these fish gradually moving shoreward. Their progress is slow as they bob head downward over the limestone surface. Assumedly they are nibbling and rasping at the substrate, as their gut contents were found to be white and gritty with limestone or fine coral sand.

It has already been mentioned that subtidal littoral barnacles are generally modified forms that are mechanically protected in some way. That this protection is from predators is problematical. That it is from rasping fish is perhaps too strong a suggestion. However, an observation made in a special situation tends to place some predators

associated with corals under suspicion. In the Truk lagoon there are several large channel markers that were put in by the Japanese prior to or during World War II. These buoys are exposed on all sides by open water and are slowly sinking due to the accumulated weight of corals growing on their submerged parts. Samples of coral broken from one of these buoys were heavily encrusted by the sessile barnacle Tetraclita (Tesseropora) sp. (Plate 20, Figure 1). The unique feature about the buoys, aside from the profusion of exposed barnacles growing with the corals, was the apparent absence of reef fishes which normally inhabit coral reefs. It is possible that fish had not become established during the period the buoys were in the water or that there

was not enough coral to support them, but it seems more likely that a lack of shelter from piscivorous forms accounts for their absence.

A somewhat analogous situation exists in the intertidal. On Heron Island, Australia, it has been observed (Endean, et al., 1956) that there is a general paucity of intertidal barnacles on high beach rock. However, barnacles were found around the higher portions of "nigger heads" or storm rocks out on the reef crest. It has been suggested (5) that, as the tide comes in, predatory fish drive the raspers into hiding or up into relatively shallow water. This leaves the higher reaches of the storm rocks free of rasping fishes and this is believed to account for the barnacles found there.

(continued next page)

EXPLANATION OF PLATES

Plate 20

Figure 1: Tetraclita (Tesseropora) sp. on the coral cf. Pocillopora sp. taken from a buoy in Moen-Dublon Channel, Truk, Caroline Islands. Note the crowded exposed barnacles encrusted with algae and aborescent bryozoa. X 2.
Figure 2: Chthamalus stellatus (Poli) on high intertidal beach rock (limestone) from Nimitz Beach, Guam, Mariana Islands. Note the uniform systematic pattern of tooth marks covering the surface of the rock. X 2.25.

Plate 21

Figure 3a: Same rock and barnacles as shown in Figure 2, enlarged. Note the parallel line of tooth marks indicated by the arrow. These were made by a single fish, probably an acanthurid, rasping, bite after bite, across the face of the rock. These marks are conspicuous because they are more recent than the surrounding marks and algae have not grown in to restore the natural color. The small barnacles (near center) were narrowly missed by the teeth of the fish that made these marks. X 7. Figure 3b*: Profile of the jaws and teeth of Acanthurus. Figure 3c*: Profile of the jaws and teeth of Chaetodon.
Figure 4a: Same rock as shown in Figure 2, enlarged. Note the large tooth marks that have resulted from a single rasping bite of fish on the projecting edge of the rock. The fish was probably a balistid or wrass. Marks of this size were infrequently encountered on the rocks of Nimitz Beach. However, rock from Truk, Kapingamarangi, and Majuro was commonly and heavily scarred in this way. X 6. Figure 4b*: Profile of the jaws and teeth of a labriid.
Figure 4c*: Profile of the jaws and teeth of Balistes.

* Not to scale



Figure 1

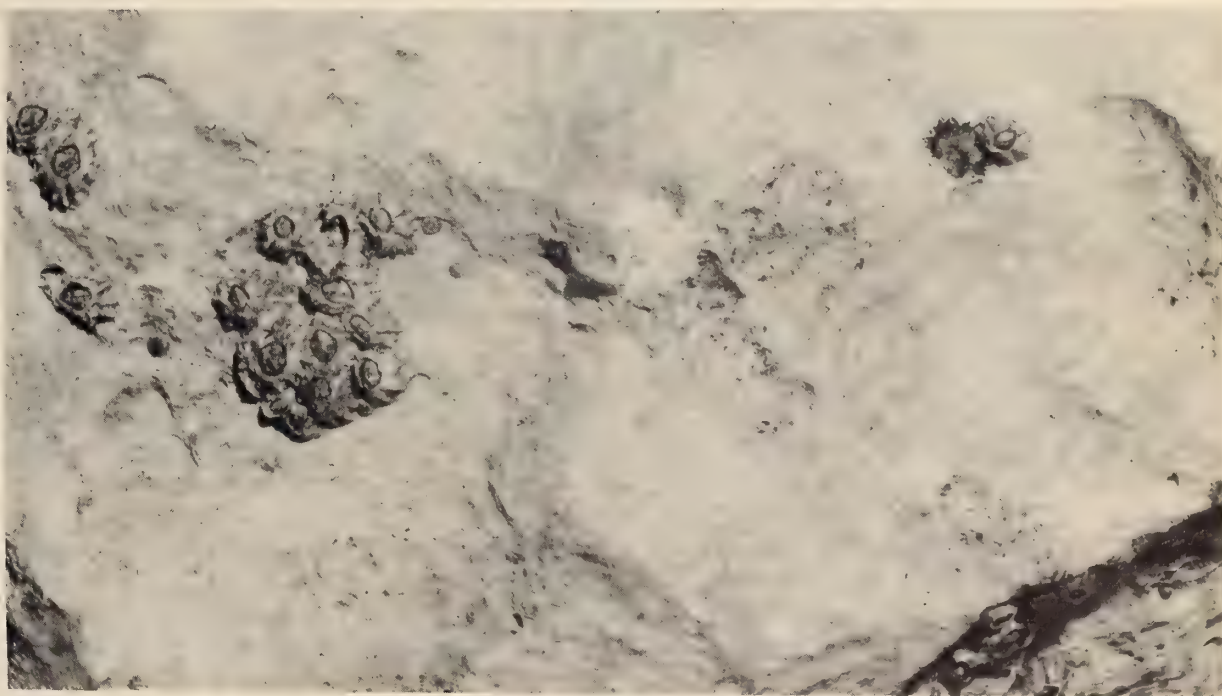


Figure 2

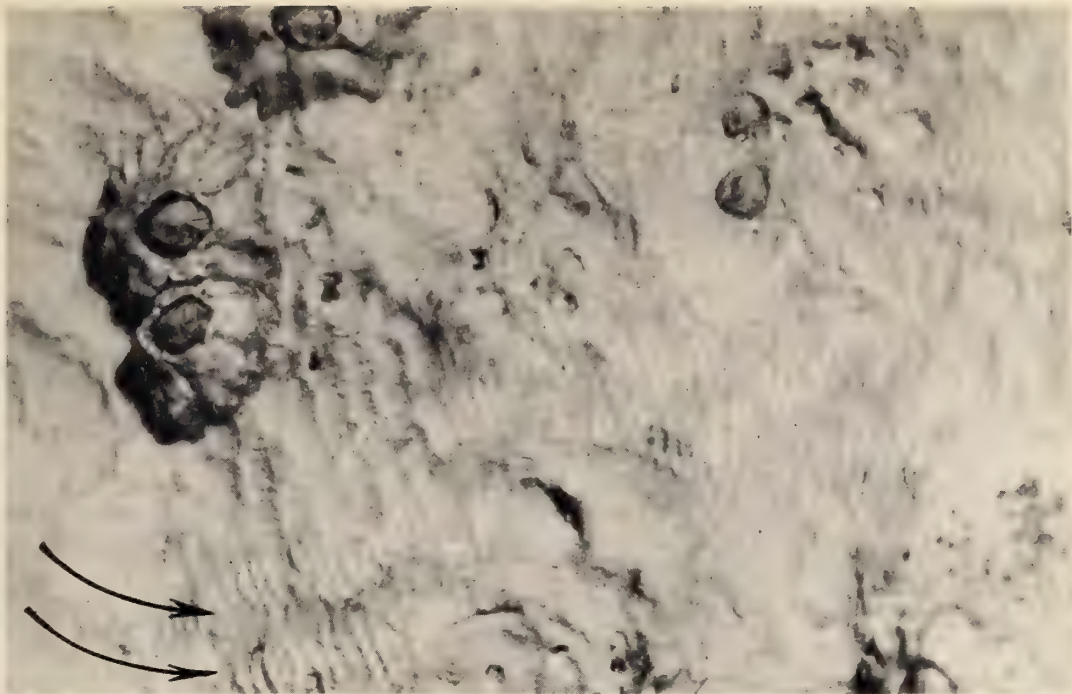


Figure 3 a



Figure 3 b



Figure 3 c

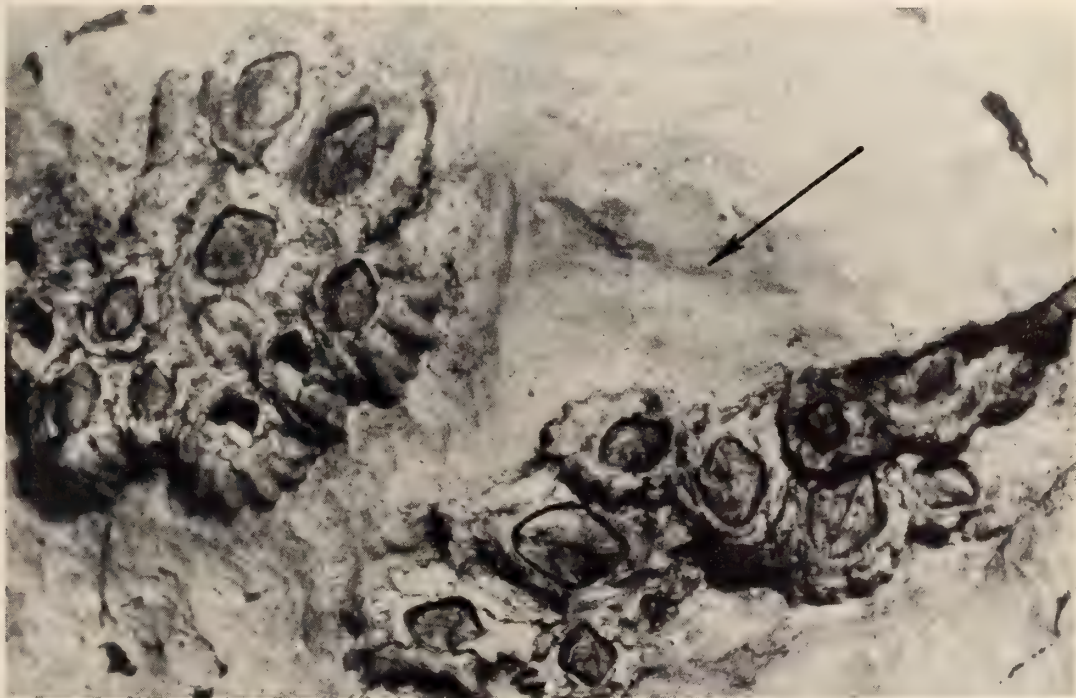


Figure 4 a



Figure 4 b



Figure 4 c

Similar to the case of the storm rocks are the conditions surrounding high beach rock. Water covers these areas only during high tides and then for only brief periods of time. Settling barnacles would have a slightly better chance of becoming established because of the less frequent raspings of smaller fish. The only situations associated with coral rock where sessile barnacles were found in abundance was on high beach rock from Guam, Truk, and Kapingamarangi (2), and such observations tend to support this supposition (Plate 20, Figure 2; Plate 21, Figures 3a and 4a).

In Mangrove swamps, barnacles are fairly common. In a small muddy estuary at Truk a rock road had been built and barnacles associated with a small mussel were abundant. This was the only situation where a thin-shelled bivalve was seen as a conspicuous intertidal form. Limestone is not exposed in these areas and, consequently, rasping fish are not found there.

The evidence presented here is based entirely on field observations and is highly circumstantial. It is believed that coral-rasping fish are primarily responsible for the paucity of intertidal barnacles, not necessarily by direct predation, but as a side effect to their thorough and systematic rasping of algae-bearing substrates. No observations were made regarding depredations by mollusca (Barnawell, 1960), especially by gastropods (Paris, 1960). It remains for experimental evidence gained from barnacle transplants, predator enclosures, and studies of possible predators themselves to prove or disprove that it is primarily predation of any sort that accounts for the major distributional aspects and relative paucity of intertidal cirripedia in the tropical western Pacific.

I would like to express my gratitude to Dr. R. I. Smith for his helpful advice and criticisms of the

manuscript. The figures of fish teeth were made by Mrs. Emily Reid, Staff artist, to whom I am very grateful. I would like to thank Stephen A. Wainwright of this Department for the identification of the coral taken from buoys at Truk.

EXPLANATION OF CODE NUMBERS IN TEXT.

- (1) Specimens collected by the author at Truk, Caroline Islands.
- (2) Specimens collected by Dr. Cadet Hand (Dept. Zool., U. C., Berkeley) at Kapingamarangi Atoll, Southern Micronesia.
- (3) Specimens collected by Mr. Stephen A. Wainwright (Dept. Zool., U. C., Berkeley) at Kaneohe Bay, Oahu, Hawaii.
- (4) Specimens collected by the author at Guam, Mariana Islands.
- (5) The suggestion that fish may account for the situation seen on storm rocks was made by Dr. William Stephenson (Dept. Zool., Univ. Queensland, Brisbane) in a personal communication to Mr. Richard Searles (Bot. Dept., U. C., Berkeley) while they were on Heron Island, Australia. Mr. Searles in turn related it to me.

LITERATURE CITED.

- Barnard, K. H.
1924. Contribution to the Crustacean fauna of South Africa. 7 Cirripedia. Ann. S. Af. Mus. 20(1): 1-103.
- Barnawell, Earl B.
1960. The carnivorous habit among the Polyplacophora. Veliger, 2(4): 85-88.
- Darwin, Charles
1851-54. A monograph on the subclass Cirripedia. London.
- Endean, R., W. Stephenson, and R. Kenny
1956. The ecology and distribution of intertidal organisms on certain islands off of the Queensland Coast. Australian J. Mar. & Freshwater Res.

7(3): 317-342.

Paris, Oscar H.

1960. Some quantitative aspects of predation by Muricid snails on mussels in Washington Sound.

Veliger, 2(3): 41-47.

Pilsbry, Henry

1916. The sessile barnacles (Cirripedia) contained in the collections of the U. S. National Museum, including a monograph of the American species. Bull. U.S. Nat. Mus. #93.

SPECIES OF THE GENUS CYPRAEA FROM CLIPPERTON ISLAND

by

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and

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(Plate 22)

The composition of the molluscan fauna of Clipperton Island is remarkable for its mixture of West American and Indo-Pacific elements.

In a recent number of this quarterly, Allison (1959) discussed the habitat of the species of Conus found living on this atoll. Empty shells of three additional species, Conus brunneus Wood, C. gradatus Mawe, and C. tessulatus Born also have been taken there. The present paper is based primarily upon material collected during Scripps Institution of Oceanography Expeditions of 1956 and 1958 to Clipperton Island.

The species of Cypraea are a colorful and conspicuous element of the shallow water fauna in tropical waters. Twelve species and subspecies are here listed from Clipperton Island: the identification of two is doubtful and the identification of one species recorded earlier from the island may be open to question. All are Indo-Pacific species except two, Cypraea albuginosa and C. isabella mexicana, which live in tropical west American waters.

We wish to acknowledge the aid of

Mr. Ray Summers who checked the identifications of the species which follow:

Cypraea albuginosa Gray. Live specimens rare, taken at edge of reef-flat; fresh shells from reef-flat and among coral debris to a depth of 10 meters; beachworn shells on all beaches but especially common on north and west sides of the island where shells of C. isabella mexicana are relatively uncommon.

Cypraea arenosa Linnaeus. A single worn specimen from the beach on the north side of the island.

Cypraea caput-serpentis Linnaeus. Fresh shells from the beach on the north side of the island.

Cypraea depressa Gray. Worn shells from the beach.

Cypraea helvola Linnaeus. Worn shells fairly common on the beach on the north and west sides of the island.

Cypraea isabella Linnaeus. Recorded from Clipperton Island by Hertlein and Emerson (1953). Identified as C. isabella mexicana by R. Summers (oral communication).

Cypraea isabella mexicana Stearns.



Figure 1. *Cypraea moneta* Linnaeus; Hypotype 37726, Univ. Calif. Mus.
Paleon. Type Coll., Loc. B-4237. Clipperton Island, living. x 2



Figure 2. *Cypraea moneta* Linnaeus. Hypotype 37727, Univ. Calif. Mus.
Paleon. Type Coll., Loc. B-6098. Clipperton Lagoon, dead. x 2

Two live specimens from the reef-flat on the north side of the island and one from a depth of 10 meters. Fresh shells fairly common on the north and west sides of the island; abundant worn shells all around the island. Largest specimen is 52 mm. long, 30 mm. wide, convexity, 25.5 mm.

Cypraea maculifera Schilder (= C. reticulata Martyn). A single worn shell on the beach-flat on the north side of the island.

Cypraea moneta Linnaeus. (Plate 22, Figure 1) Worn shells on all sides of the island, especially in areas protected from violent waves.

Cypraea moneta Linnaeus, elongate variety. (Plate 22, Figure 2) Chalky shells on the shelf side of the lagoon at depths of approximately 10 meters, in coral sand, associated with paired valves of Codakia in sand between remnants of coral ridges.

Cypraea scurra Gmelin. Fresh as well as worn shells on the rocky beaches.

Cypraea teres Gmelin. Fresh as well as worn shells on the rocky beaches.

Cypraea cf. C. vitellus Linnaeus. Single worn specimen from the beach-flat on the north side of the island.

LITERATURE CITED.

- Allison, E. C.
1959. Distribution of Conus on Clipperton Island. The Veliger, Vol. 1, No. 4, pp. 32-35.
Hertlein, L. G., and Emerson, W. K.
1953. Mollusks from Clipperton Island (eastern Pacific) with the description of a new species of gastropod. San Diego Soc. Nat. Hist., Transactions, Vol. 11, No. 13, pp. 345-364, pls. 26-27.

FURTHER NOTES ON BERINGIUS

by

Allyn G. Smith

California Academy of Sciences, San Francisco, California

(Plate 23)

Since publication of my notes on the apparent variability of Beringius eyerdami A. G. Smith (The Veliger, 1960) sixteen more specimens taken by trawlers from the same general area have been received for study. Fourteen of these were supplied by Mr. and Mrs. John Q. Burch of Los Angeles; the other two by Mrs. W. S. Duggan of Everett, Washington. This makes a total of about 50 specimens of B. eyerdami and its relatives that have become available.

For convenient reference all specimens received since Beringius eyer-

dami was originally described and figured (Nautilus, 1959) have been designated with an "S" and a serial Roman numeral. It should also be noted that the two specimens figured on Plate 14 of The Veliger for January, 1960, are now in the Paleo-Type Collection of the California Academy of Sciences through the courtesy of Mr. Everett C. Stiles, who obtained them from trawler captains.

Of the 14 specimens loaned by Mr. and Mrs. Burch, 10 are the normal heavily-ribbed form with relatively short spire and globose body whorl,

although like others handled previously, there is some variation in sculptural characters within what is considered to be expected limits. The ratio of height to maximum diameter (H/D) in these as in other normal shells of the species ranges from about 1.5 to 1.7 with a single specimen having an H/D of 1.77. Three shells in the Burch lot (S-XIII, XX, and XXI) have longer spires, however, with H/D's of 1.80, 1.82, and 1.90, respectively. They are typical in other respects, although it must be admitted that in this respect they come close to what is considered to be normal B. undatus Dall, which has an H/D ranging from 1.85 to almost 2.4, based on the few specimens that have been at hand. The remaining Burch specimen (S-XXII) is the so-called smooth form without any heavy spiral ribs.

Mrs. Duggan's two shells (S-XXIII, XXIV) were taken by the trawler "Marie II", November, 1959, in 42 fathoms, rock bottom, on Swift Shore Bank, 12 miles West of Cape Flattery, Washington. Neither is normal Beringius eyerdami, but both are allied with the "smooth" form already mentioned. S-XXIII is relatively long-spired (H/D 1.86), has three major spiral ribs on the base of the body whorl adjacent to the canal, and may have had some finer spiral cording

on this whorl when fresh although evidences of this have been all but eroded away. S-XXIV, however, is a live shell with the operculum and with the nuclear tip complete. It is short and globose, with an H/D of 1.50. On this shell there are two broad spiral ribs at the base of the body whorl adjacent to the canal, set off by narrow, shallow, incised channels, above which is a broad area 5-6 mm. wide, set off above it by another such incised channel. On the body whorl from its summit to a point well below its periphery are a series of unequally-spaced, raised, spiral cords, about 10 in number, some of which are broken and incomplete around the whorl. Transverse plications, most prominent at the whorl summits, are numerous on this shell, there being 15 on the body whorl, 13 on the penultimate whorl, and 14 on the antepenultimate whorl. The body whorl summit is tabulate, but on the penultimate whorl, it dips down into the suture. The nuclear whorls are about 2, smooth (eroded?) and tapering to a blunt point. Microsculpture worn off except for the very fine, closely-spaced series of growth lines.

So far, a total of 7 specimens of the so-called smooth form of Beringius eyerdami have been studied. All but one of these - the one described in detail above - are relatively long-

Explanation of Plate 23

Figure 1. Beringius eyerdami A. G. Smith, smooth form. Specimen S-XXIV. Back view of the so-called smooth form with short spire and globose body whorl from 42 fathoms, rock bottom, Swift Shore Bank, 12 mi. W. of Cape Flattery, Wash. Length 96.9 mm. Calif. Acad. Sci. Paleo. Type Coll. (from Mrs. W. S. Duggan). Figure 2. Enlarged view of nuclear whorls of specimen S-XXIV. x7. Figure 3. Beringius eyerdami A. G. Smith. Specimen S-XX. Apertural view of a relatively long-spired shell supposedly taken in about 100 fathoms, La Perouse Bank, 40 mi. off Cape Flattery, Wash., the exact locality uncertain. Length 132.9 mm. (Burch Coll.) Figure 4. Beringius eyerdami A. G. Smith. Specimen S-XIX from same locality as S-XX, above. Enlarged view of complete nuclear whorls. x9.

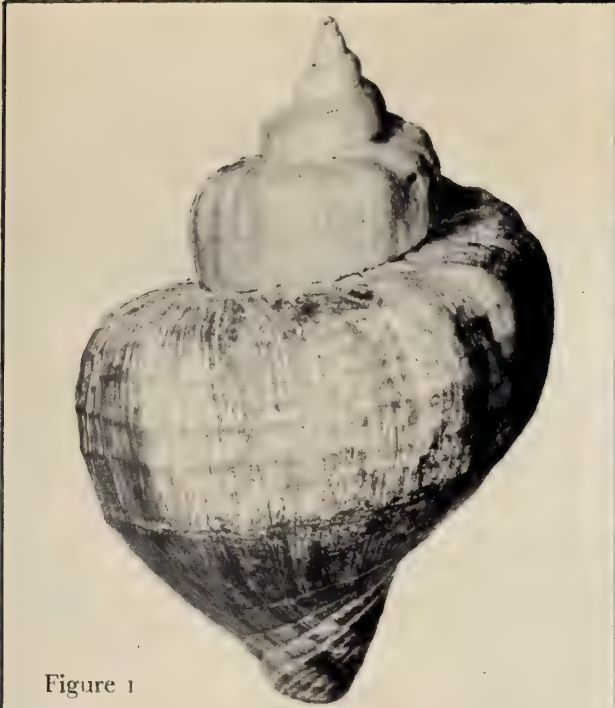


Figure 1



Figure 2



Figure 3



Figure 4

spired, their H/D's ranging from 1.6 to 1.82, with an average of more than 1.7. Thus there is yet no clear evidence, statistical or otherwise, that warrants the step of giving this form a separate scientific name.

LITERATURE CITED.

Smith, Allyn G.

1959. A new Beringius from the Pacific Northwest with comments on certain described forms. Nautilus, vol. 73, no. 1, pp. 1-9, pls. 1-3, July, 1959; vol. 73, no. 2, pp. 43-46, October, 1959 (continuation).

1960. Additional notes on Beringius. The Veliger, vol. 2; no. 3, pp. 57-60, pls. 13-14, January 1, 1960.

(Hanna & Rixford). All three species seem to be quite rare. They have been found usually in shaded rock-slides. So far T. tehamana has been known only from the original lot.

While collecting in the Shasta River Canyon, Siskiyou County, in the summer of 1931, specimens of Trilobopsis were collected in rock piles along the bank of the river about one mile from its junction with the Klamath River. At first these were thought to be a new species, but on subsequent comparison with a paratype in the collection of the California Academy of Sciences, it was concluded they should be identified as T. tehamana. This is an extension of the range of the species to the northward. Additional specimens were collected in 1934 in the same type of habitat but 2-3 miles from the mouth of the river.

Other land snails collected with T. tehamana in the area included:

Monadenia chaceana Berry
Vespericola sierrana Berry
Vallonia cyclophorella Ancey
Fristiloma chersinella Dall

NOTES & NEWS

NOTE ON TRILOBOPSIS TEHAMANA (PILSBRY) A RARE NORTHERN CALIFORNIA LAND SNAIL

by
Allyn G. Smith
Research Malacologist
California Academy of Sciences

The small Californian mountain snail, Trilobopsis tehamana (Pilsbry) was collected first by R. C. McGregor of the former U. S. Fish Commission in the Canyon of Butte Creek, Tehama County, California. Pilsbry described it in 1928 as a third of a closely related group of polygyroid species, the other two being T. roperi (Pilsbry) and T. penitens

METHODS & TECHNIQUES

A COLLECTING DEVICE FOR SMALL LAND ANIMALS

by
Jack T. Tomlinson
San Francisco State College
San Francisco, California

Slugs, worms, isopods, and ground-dwelling insects can be conveniently trapped over a period of time by placing a jar, can, or bucket in a hole and filling around it so that the top is flush with the ground. This method has been used for some time by herpetologists and mammalogists; however, a weakness in its use for invertebrates is that the animals escape more readily, and the

pits have to be checked frequently before the animals decompose or damage themselves.

If pit traps are partially filled with a preservative topped with a layer of non-odorous mineral oil, the specimens can collect for a month between inspections. Light-weight oil is required to give a thinner layer of less dense oil through which the animals can easily fall and become preserved. Bait can be floated on small pieces of wood on the oil. Holes in the ground can be lined with a plastic sheet, covered by dirt on the apron to allow access by the animals. A board or piece of roofing paper arched over the pit is desirable.

INFORMATION DESK

HOW TO BUILD A PRIVATE COLLECTION WHICH IS SCIENTIFICALLY VALUABLE

by

R. Stohler.

Department of Zoology
University of California, Berkeley

(Concluded)

Part IV: Cataloguing.

The various procedures outlined so far are really sufficient to make any collection of enough scientific value so that it will not end up in the discard. However, in larger collections it may become very desirable to add a further refinement, one which will permit intensive or extensive research work coupled with an economy of time. This may be accomplished with a good system of cataloguing.

A catalog may be designed to fulfill a particular purpose or it may be developed for more general use. But no matter what the goal may be, it will be found that a card catalog will be most flexible and, consequently,

most useful.

In the catalog should be found again all pertinent information that has been collected with the specimen; but, further than that, it should also contain any information that may accrue subsequently, such as the disposition of part of a lot (gift, exchange, etc.); or correction of identification, if it were found that the original lot consisted actually of two or more (possibly closely related) species, etc. It seems best to make a separate card for each lot of each species.

In our collection we use a double entry system. Two cards, exactly alike (see Figure 2), are prepared for each lot. This sample card will serve also to show what information is entered on each card. The two cards are filed in separate files; one file is maintained for the species, arranged alphabetically, regardless of class; the second file is arranged, again alphabetically, according to locality where the collections were made. Under the species names, the various cards are arranged according to geographical latitude, while under the locality names the cards are arranged alphabetically by species names. Thus, it is possible to ascertain practically at a glance what may be found in a given locality or what the total range of a certain species may be (assuming in both instances that the collection is fairly complete). To further facilitate the use of the catalog, we have adopted a code of colored inks for the different classes of mollusks. Black ink is used for gastropods, green for patency-pods, red for scaphopods, and blue for amphineurans (we don't collect cephalods). In some museums additional color codes are used to separate the lots into geographical units; a faintly red paper might be used for African species, while a blue tinged paper might indicate an Australian origin. Labels in the

exhibit cases may have like colored borders to indicate the major continents. However, no matter what sort of code may be used, it must be emphasized that the code should be explained completely and adequately in the card files and in other appropriate places. In our case, we insert a

Yet it is really a simple matter since the arrangement will depend on the purpose of the collection and the space available. The fundamental principle, however, remains the same, no matter what particular scheme may be followed: a given lot of a particular species should be readily

<i>Acmaea funiculata</i> CARPENTER	Accession No. 1673
	42 specimens in lot
seaward side of North Island, Los Coronados, Baja California, Mexico.	
on top and sides of large rocks and ledges in 150 feet	19 July 1957
Fager, Ghelardi, Stewart, Clarke, coll.	
32° 27' N. 117° 11' 45" W.	

Figure 2: Replica of Catalog Card as used in the Department of Zoology at the University of California in Berkeley

code explanation at the front end of each and every file drawer.

It should be stressed that the method described is just one of many different possible methods. And no matter what kind of catalog is maintained, if it is complete, it will add proportionately to the overall scientific value of the collection - provided that there are no "secret" codes employed.

Part V: Arranging a Collection.

While the arrangement of a collection does not necessarily add to its scientific value, it poses nevertheless a problem to many collectors.

located when needed.

We have seen some very large collections where the owner found it necessary to arrange his shells according to size, because of his space problem. This may be convenient but it proved extremely difficult and time consuming to locate any particular specimen unless it was the very largest or the very smallest in the entire collection.

Most institutional collections are arranged according to the systematic relationship of the various species. Such an arrangement is extremely useful but it presupposes that the person in charge is completely conversant with the systematic position of

every genus. It permits, however, locating any desired specimen with a minimum of effort.

Still another method of arranging a collection may be the alphabetical; that is to say, the genera are arranged in strict alphabetical sequence regardless of their true affinities; the species, in turn, are arranged alphabetically under their proper genus. Such an arrangement has the great advantage that any desired species may be located almost instantly, even by a novice; but it has the great disadvantage that when related genera are to be studied, they must be assembled from different drawers and even from different cabinets.

Part VI: Conclusion.

It is undoubtedly unnecessary to stress that the suggestions contained in the various parts of this article are nothing more than hints on what can be done by an individual amateur to insure that his collection may become perhaps someday the basis for some very important scientific discovery. There is nothing in the world to prevent him from just acquiring in any manner whatsoever any pretty shell that may attract his fancy and to display it in any manner he sees fit. If he desires, however, that his collection may continue to give joy and to have value, then he will want to obtain and preserve as much information about each item as he possibly can - just as was outlined earlier.

From past experience it seems very necessary to stress that a collection may have a very high scientific value but a very low monetary value. The two do not go hand in hand, perhaps unfortunately so. On the other hand, no scientific institution would be willing to pay even a nickel for the most beautiful collection of shells, accompanied by such information as

"Japan", "Europe", etc. This does not mean that a collector might increase the value of his collection by manufacturing information. Such a procedure would not only be dishonest and highly reprehensible, but could be of almost tragic scientific detriment since new "locality records" and range extensions might be "discovered". Such falsified records would require a great amount of effort and time to clear up and to rectify, effort and time which are urgently needed for straight-forward scientific work.

Essentially the same reasoning applies to the collecting of the specimens themselves. Only living specimens should ever be used as records, since dead shells may have been carried far afield by tourists or by ocean currents and flashfloods. Modern observations with SCUBA and with the Bathyscaphe have shown the presence of strong ocean currents that may carry dead material for great distances. Not even depth records can any longer be accepted on the basis of dredged dead shells.

BOOKS, PERIODICALS, & PAMPHLETS

Pectinidae of the Eastern Pacific by Gilbert Gran. Allan Hancock Pacific Expeditions, Vol. 23, 308 + viii pp., 57 pls., Sept. 25, 1959. University of Southern California Press, Los Angeles. \$4.50.

Not many malacologists have the courage to attempt so large a work as this, and still fewer would carry it through so successfully. It is a compendium of information on West American pectinids - the location of type material, geographic and geologic range of the species, ecology, and morphology. One may safely predict that it will be years before the need is felt for a further revision of the group. The high-quality pho-

tographic illustrations alone would make the book worthy of note. Although the grid-like backgrounds of some figures may puzzle the user at first glance, this, being the weave of a bit of fabric, serves as a clue to the magnifications for the smaller shells.

The book begins with a key to the 16 generic taxa that are recognized -- seven genera and nine additional subgenera. Thirty-two species and sub-species (six of the latter) are discussed, and full synonymies are given. Seven of the species are new, of which five are in Cyclopecten, two in Pecten. A bibliography and index add a final touch of completeness to the work. It seems to be exceptionally free from the typographical and other blemishes that inevitably creep into an undertaking of its size and can be heartily recommended as a "must" item for any library on West Coast mollusks.

On two points of nomenclature, however, a question may be raised. The first is a minor matter of the spelling of a specific name. The transfer of species originally named as Pecten to the genus Chlamys (a noun of feminine gender, whereas Pecten is masculine) necessitates the changing of endings for most of the specific names that are adjectives. Grau has done a good job on this (no easy task in these days of scant emphasis on classical language), but the name hericius should remain unchanged (not Chlamys hericia as he has it on page 87), for classicists advise that this is a noun, not an adjective, derived from the Latin word ericius, hedgehog. The second point has to do with the revival of Argopecten Monterosato, 1889, for certain species that have been classed either under Aequipecten Fischer, 1886 -- the type species of which is a European form -- or Plagioctenium Dall, 1898, type P. circularis. Monterosato himself (Jour. Conchyl.,

vol. 47, p. 193, 1899) designated the type species of Argopecten as Pecten solidulus Reeve. The genus must be judged on the basis of this designated species, not on any others that Monterosato may (rightly or wrongly) have cited in its synonymy. At least this is the conventional interpretation of the International Rules. Grau admits that P. solidulus Reeve is an unidentifiable form. Can Argopecten, then, be given acceptance legally? Aequipecten is not, in Grau's opinion, an appropriate category for our species, P. circularis and its subspecies, P. c. aequisulcatus and P. purpuratus. Should they not be allocated to Plagioctenium rather than to an equivocal group such as Argopecten?

Taxonomy wears two faces -- nomenclature and classification. The former is governed by objective rules, as implied above. Classification, however, is subjective ranking, a matter of judgment. It changes with the changing viewpoints of systematists, and each new reviser has the privilege of suggesting modifications. Grau's classification of West American Pectinidae seems, on the whole, to be a good compromise between the extremes of over-splitting and of over-conservatism. Whether it will be accepted in detail -- as, for example, whether Delectopecten is best considered a subgenus of Cyclopecten or Leptopecten of Chlamys -- only time (and not this reviewer) can decide. Recognition of the subgeneric category Oppenheimiopecten for the group of P. vogdesi seems new and strange to our eyes, but this may well prove to be a useful subdivision.

We owe Mr. Grau a vote of thanks for having given us this praiseworthy monography.

- A. Myra Keen

We are pleased to be able to announce that the following have agreed to join the Editorial Board as of July 1, 1960:

Dr. Donald P. Abbott
Associate Professor of Biology
Hopkins Marine Station
of Stanford University
Pacific Grove, California

Dr. E. W. Fager
Associate Professor of Marine Biology
Scripps Institution of Oceanography
University of California
La Jolla, California

Backnumbers of The Veliger:

As previously announced, the subscription price for The Veliger will have to be increased as of July 1, 1960, with the beginning of Volume 3. At the same time we will have to increase also the price for backnumbers which will be sold, as long as supplies last, as follows:

Any number of Vol. 1	25 cents each
No. 1, Vol. 2	35 cents
No. 2, Vol. 2	35 cents
No. 3, Vol. 2	60 cents
No. 4, Vol. 2	70 cents

In addition we are forced to charge for postage and also to make a handling charge of 25 cents for each order.

A.M.U.-P.D. 1960

As of the date of going to press with this number, the Secretary, Mrs. Zellers, 714 Elm Street, El Cerrito, reports a fair number of reservations received. The plans for the convention are taking shape; the general program will include a reception and get-together on Wednesday afternoon, June 22. A field trip to the rich rocky area on one of the many beautiful outcroppings of the Monterey Peninsula under the leadership of Mr. Allyn G. Smith, Research Malacologist, California Academy of Sciences, is planned for Thursday morning. We have been fortunate in obtaining two excellent main-speakers, one for Thursday after dinner, and one for Friday after the banquet. On Thursday, Mr. La-Marr of the California Department of Fish and Game will talk about problems of the Game Laws as they apply to shell collectors; on Friday Dr. Donald P. Abbott of Hopkins Marine Station of Stanford University will talk on his experiences in a South Pacific Atoll. On both evenings, after the speeches, there will be a one-hour session of shell auction, followed by informal get-togethers, color slides, private shell swapping, etc. On Friday morning a field trip to Elkhorn Slough is projected under the leadership of Mr. Vernal Yeadon, Curator of the Natural History Museum in Pacific Grove.

While the dead-line for submitting papers was set for March 15, we will consider additional papers even up to the beginning of the sessions. However, it must be understood that any such late papers must risk not being presented or must be presented at such times as can be found during the regular scheduled program. Furthermore, it may not be possible for the authors of such late papers to have all the facilities available that they may consider necessary, as the various committees will not be able to provide them at that late date.

Although thirteen is often called an unlucky number, we think that this thirteenth convention of the PACIFIC DIVISION will be one of the outstanding events in the history of our Association. So that you may not be sorry later on:

COME ONE - COME ALL!

Rudolf Stohler, Chairman

A. M. U.-P. D.

c/o Department of Zoology
University of California
Berkeley 4, California

THE VELIGER is open to original papers pertaining to any problem concerned with mollusks from the Pacific Region.

This is meant to make facilities available for publication of articles from a wide field of endeavor. Papers dealing with ecological, morphological, anatomical, physiological, distributional, taxonomic, etc. aspects of marine, fresh water or terrestrial mollusks from any region bordering on or situated within the Pacific Ocean, will be considered. Even topics only indirectly concerned with mollusks may be acceptable.

It is the editorial policy to preserve the individualistic writing style of the author; therefore any editorial changes in a manuscript will be submitted to the author for his approval, before going to press.

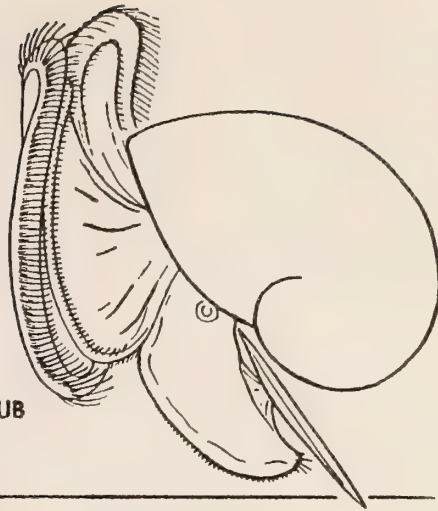
Short articles containing descriptions of new species or lesser taxa will be given preferential treatment in the speed of publication provided that arrangements have been made by the author for depositing the holotype with a recognized public Museum. Museum numbers of the type specimens must be included in the manuscript. Type localities must be defined as accurately as possible with geographical longitudes and latitudes.

Short original papers, not exceeding 500 words, will be published in the column "NOTES & NEWS"; in this column will also appear notices of meetings of the American Malacological Union, as well as news items which are deemed of interest to our subscribers in general. Articles on methods and on techniques will be considered for publication in another column, provided that the information is complete and techniques and methods are capable of duplication by anyone carefully following the description given. Such articles should be mainly original and deal with collecting, preparing, maintaining, studying, photographing, etc., of mollusks or other invertebrates. A third column, entitled "INFORMATION DESK," will contain articles dealing with any problem pertaining to collecting, identifying, etc., in short, problems encountered by our readers. In contrast to other contributions, articles in this column do not necessarily contain new and original materials. Questions to the editor, which can be answered in this column, are invited. The column "BOOKS, PERIODICALS, PAMPHLETS" will attempt to bring reviews of new publications to the attention of our readers. Also, new timely articles may be listed by title only, if this is deemed expedient.

Manuscripts should be typed on a high grade white paper, 8½" by 11", double spaced and accompanied by a carbon copy.

THE VELIGER

A Quarterly published by
NORTHERN CALIFORNIA MALACOOLOGICAL CLUB
Berkeley, California



Volume 3

July 1, 1960 to April 1, 1961

Foreword to Volume Three

Much of what was stated in the Foreword to Volume Two could be repeated this year. The financial picture is, perhaps, just a little less gloomy than it was a year ago. Of course, this is a relative statement and merely means that the total deficit has not increased as much as the year before. This may be ascribed to the fact that we increased the subscription rate but also to the fact that we kept the magazine from increasing in size as much as it might have, had we had unlimited funds available. We are proud, of course, that all of the growth has been achieved without support from any governmental agency and thus no taxpayer, directly or indirectly, has to worry about his tax rate on our account. Through our new increase in the subscription rate we hope to "balance our budget" for Volume Four and, barring unforeseen events, even start reducing the accumulated deficit. Eventually we hope to compensate some of those who are contributing so much of their time and talent, if not in a commensurate way, at least in a way which more fully expresses the appreciation due these persons.

All of the typing for Volume Three was done by Mrs. Heidi Stohler Norskog. The art work, as before, owes its excellence to the unsurpassed skill of Mrs. Emily Reid. All letterpress work was done again by your editor. Our good friends from the Printing Department of the University Press have continued guiding us past some pitfalls lurking for the less experienced publisher and editor. Their indirect contributions have again been very valuable and have assisted in keeping the deficit to a minimum. To these men we wish to tender our special thanks: Earl Gustafson, Louis Rengel, John Schoen and Charles Peckham. The list of Errata which we present with due apologies for its necessity was compiled by Mrs. Jean Cate of Los Angeles. Dr. Phyllis Kutsky has graciously continued the task of indexing the journal, in spite of various and new handicaps.

However, many other persons have assisted in one way or another. These include the members of the Editorial Board, the Officers and Members of the Northern California Malacozoological Club, as well as the remaining members of the editor's immediate family, the latter assisting in assembling and mailing the journal. To all these people, named and unnamed, go the sincere thanks of

The Editor.

Berkeley, California,
April 16, 1961.

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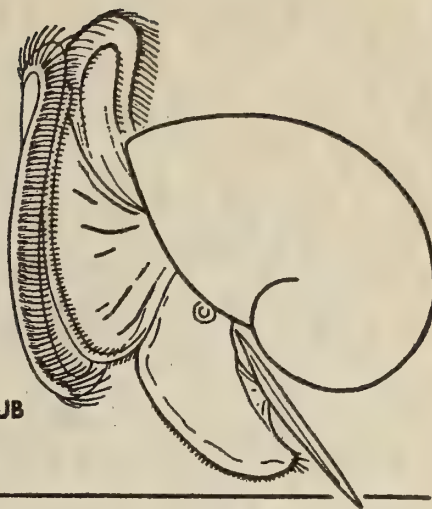
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Vermetid Gastropods and Marine Intertidal Zonation

by

A. MYRA KEEN

Department of Geology, Stanford University, California

In 1949, Dr. T. A. Stephenson and his wife, Anne, who had been studying marine life between the tide-marks for several years, proposed a zonation that has been widely accepted by marine ecologists. The strand was thus divided into: a) the *Infralittoral Zone*, for the area beyond extreme low water level; b) the *Littoral Zone*, from extreme low water to extreme high water; and c) the *Supralittoral Zone*, above that. As the *infralittoral* (or as some workers prefer, the *sublittoral*) zone is out of reach of the collector (unless he becomes a diver) and the *supralittoral* zone carries no truly marine life, the principal area available for study is the *littoral* zone, which the Stephensons would divide, again, into three parts, the *Infralittoral Fringe*, from extreme low water to the upper limit of large seaweeds, the *Midlittoral Zone*, from there to the upper limit of barnacles, and the *Supralittoral Fringe*, up to the upper limit of the *Littorinas* (or their equivalents where they are absent). These zones are based upon plant and animal communities, not upon physical factors such as tides, wind and wave conditions, temperature, etc. Of course, it is to be expected that local variations of the pattern will occur and that in some areas parts of the zones may be suppressed or in others that yet finer divisions might be possible.

The Stephensons have subsequently tested their scheme at several places, and their descriptive accounts of such regions as the Florida Keys, Nova Scotia, and Bermuda are recommended reading for the serious student. Their promised reports on our own West Coast (the Puget Sound area and La Jolla) will give us fresh insights into our area. The complexities of the physical factors involved in interpreting zonation have been stressed by such authors as Doty (1957) and Moore (1959), for the meeting of sea, air, and land provides anything but a simple situation, and it is one difficult to study. Although the Stephenson scheme has in general proved useful, one may wonder—because it was drawn up mainly from work

along the temperate and warm-temperature coasts of the east and west Atlantic—whether it would apply along an arid tropical coast such as we have in parts of West Mexico.

I had an opportunity to observe such a region last November, when I was a guest of the Belvedere Foundation, on a three-day trip to the southern end of Lower California. Not expecting to find good collecting grounds in so short a stay, I went with the intention of studying zonation if it were observable and of watching for my pet gastropods, the vermetids. In an earlier experience at Punta Peñasco, I had gained the impression that our common temperate intertidal invertebrates were almost entirely replaced by other forms and that zonation was not clear-cut. This proved to have been a superficial judgment, for in the La Paz area I saw the three-fold divisions of the *midlittoral* zone even more sharply displayed than they are along Californian shores. However, the physical factor of extreme dessication under a tropical sun in an atmosphere of low humidity erases most or even all green algae above the *infralittoral* level, leaving a thin and spotty veneer of the more hardy coralline algae. In spite of the sparse algal pasture, *littorines* are present on the rocks, and barnacles of two or three kinds cluster below them. What I had not been prepared to find (judging by the battered and decrepit specimens most collectors had brought back) was that at the upper edge of the *midlittoral* zone, among and just below the barnacles, there was a dense band of vermetids of several species and genera. They formed a conspicuous feature at nearly every spot we examined. This was in harmony with observations made in the Atlantic by the Stephensons, and it points up their comment that not only have the vermetids been neglected as intertidal organisms but that they may prove to be much more significant than we have realized when means for properly identifying them are made available.

A complete monograph on Panamic province vermetids is a long-term project, and in three days I could not hope to acquire

more than a sample, but what I did collect, with the loyal help of other members of the party (our plane's pilot even suffered a painfully bruised finger while chipping vermetids from a wharf pile for me) and what has subsequently been collected by Dr. S. S. Berry, Mr. James McLean, and others at my request on the east side of the Gulf, has enabled the completion of a review of the family. This is based primarily on type material at the British Museum, supplemented by the newly-collected specimens, in which soft parts may be examined. The revision is now in press and will appear as a Bulletin of the British Museum (Natural History). It departs in several respects from the tentative one in my book, *Sea Shells of Tropical West America*, because proper study of the type specimens was not possible until after the book was printed. A conclusion to be drawn from this revision is that the Gulf of California is one of the rich areas — if not the richest — in the world for genera and species of Vermetidae. Several unnamed forms have already come to light, one new *Dendropoma* having been taken by our party at Cape San Lucas. Many more are to be expected once we stop trying to fit every form we collect into the shopworn pigeonholes of "*Aletes centiquadrus*" or "*Bivonia contorta*" -- the two names most frequently used.

One observation that I hope will be given further scrutiny by workers who visit other parts of the West Mexican coast is that there seems to be a difference in relative abundance of the vermetid genera in relation to their feeding habits. *Serpulorbis*, which is a mucus feeder, attached to rocks either in a planorboid coil or in tightly attached but loosely wound or nearly straight tubes, prefers more quiet water, such as the upper ends of rocky coves. It may occur offshore in several feet of water; intertidally it is most evident in the infralittoral fringe near the lower edge of the barnacle zone. The rocks near La Paz and on Espiritu Santo Island were covered with it. *Petalocochus* (*Macrophragma*), which is apparently both a mucus and a ciliary feeder, can tolerate more vigorous surf. At Cape San Lucas, it predominated and formed a black band nearly a foot wide on the rocks, again just below the barnacles. On the most surf-beaten rocks of all, at and near Cape San Lucas, the new species of *Dendropoma* occurred. This genus is, elsewhere in the world, a

ciliary feeder. In places, as in South Africa and Bermuda, individuals are massed into such dense colonies as to form a solid veneer several inches wide at a fixed level, which may even extend for miles along a coast. The genus *Aletes* seems to be commoner offshore. Anatomy and habits of the animal have not been investigated, but the presence of an operculum suggests ciliary feeding, at least in part, although the form of the shell simulates that of *Serpulorbis*.

Obviously, much more work needs to be done before we can assess the full value of the vermetids in intertidal zonation, but these few observations, coupled with those of workers elsewhere, do suggest that the vermetids may, like the barnacles, serve as good horizon markers in our study of vertical distribution along the rocky shore.

ACKNOWLEDGMENTS

I am deeply grateful to the Belvedere Foundation and the California Academy of Sciences for the opportunity to visit the classic La Paz area. The list of persons who contributed to the success of the trip is too long to be given here, but a word of thanks is surely due to each of them.

LITERATURE CITED

- Doty, Maxwell S.
1957. "Rocky intertidal surfaces", *Geol. Soc. Amer., Mem.* 67, vol. 1, pp. 535-585, 18 figs., 1 pl.
- Moore, Hilary
1958. *Marine ecology*. New York: Wiley & Sons, pp. xi + 491.
- Stephenson, T. A., and Anne Stephenson
1949. "The universal features of zonation between tide-marks on rocky coasts", *Journal of Ecology*, vol. 37, no. 2, pp. 289-305, December.
- 1950. "Life between tide-marks in North America. I. The Florida Keys", *Journal of Ecology*, vol. 38, no. 2, pp. 354-402, November.
- 1954. "Life between tide-marks in North America. III. Nova Scotia", *Journal of Ecology*, vol. 42, no. 1, pp. 14-70, January.
- 1954. "The Bermuda Islands", *Endeavour*, vol. 13, no. 50, pp. 72-80, 4 col. pls., April.

A New Hawaiian Subspecies of *Cypraea cernica* SOWERBY

by

CRAWFORD N. CATE

Conchological Club of Southern California, Los Angeles

(Plate 1)

In the late summer months of 1959, the Pele Expedition, dredging in the coastal waters of Hawaii, brought up several specimens of *Cypraea cernica cernica* Sowerby, 1870. This species is not recognized as having been known from this locality before, yet there can be no question of its valid existence here as a well-established natural population, since twelve specimens were collected from two relatively widely separated deep-water stations.

One cannot dispute the close affinity that exists between the earlier described subspecies of *Cypraea cernica*; however, with these newly dredged specimens at hand, it was noted that obvious morphological variations were apparent when compared with those shells of the already described populations, thus suggesting a hitherto unknown race deserving taxonomic recognition.

In the study of the Cypraeidae, one question the systematics as applied to three of the polytypic subspecies of *Cypraea cernica cernica*. This problem has become even more apparent with the discovery of a new and remote deep-water population in the Hawaiian Islands. Although the differences between the subspecies of *C. cernica* are of a constant character, their distinguishing features seem not great enough to separate them on the species level from the typical species *C. cernica*, sensu stricto, found in Mauritius.

It would seem that *Cypraea tomlini tomlini* Schilder, 1930, had originally been adequately identified as *C. cernica tomlini* Schilder. Iredale (1935), on the basis of size differences alone, raised the subspecies *C. cernica tomlini* to the species level. This resulted in the subsequently described subspecies, *prodiga* Iredale, 1939, and *ogasawarensis* Schilder, 1945, being associated with the new species *C. tomlini* instead of with the original *C. cernica*. Specimens of four of the subspecies have been very carefully examined and they do not, in our opin-

ion, show enough differences to place them in any more than subspecific categories with the typical species *C. cernica cernica*. Until there are enough specimens available for a study of a series, including live-collected mollusks for comparative anatomical work, it seems inadvisable to establish a new specific form. In the interest of conserving scientific names and avoiding nomenclatural confusion, the new subspecies described below is hereby associated with its typical species *C. cernica cernica*.

The status of this species and its associated subspecies is therefore revised as follows:

Cypraea cernica cernica Sowerby, 1870

Cypraea cernica tomlini Schilder, 1930

Cypraea cernica percomis Iredale, 1931

Cypraea cernica ogasawarensis

Schilder, 1945

Cypraea cernica marielae Cate, n. subsp.

All specimens taken on the Pele Expedition were dead. Of the twelve, two were clean and fresh, obviously having recently expired; the remainder were more or less encrusted with varying amounts of lime, although all were fairly well preserved as to color and condition. None were pellucid. Of earlier record are four specimens which conform with the morphological characteristics of the new subspecies: one collected at Pearl and Hermes Reef (Ditlev Thaanum Collection), two from Midway Island (Bishop Museum Collection and C. M. Burgess Collection), and one beach specimen collected at Pomaluu on the north shore of Oahu (C. M. Burgess Collection).

Two specimens, the holotype and paratype No. 1, were dredged at 55 fathoms in the deep-water trough that exists in the ocean triangle formed by the islands of Maui, Lanai, and Molokai (20°57' N. Lat., 156°47' W. Long.). Ten additional specimens were brought up on different dates and in different dredge hauls, in from 65 to 100 fathoms, roughly a mile south of Keehi La-

Table 1: Comparative Index for

SPECIES	COLUMELLAR TEETH	LABIAL TEETH	AVERAGE SIZE
<u>Cypraea cernica</u> <u>cernica</u> (Mauritius)	Bold, strong, long, extending well over on base	Long, extending almost to margin	23.8 mm.
<u>Cypraea cernica</u> <u>ogasawarensis</u> (Bonin Islands)	Fine, shorter, less defined	Lengthened uniformly to lip	28.7 mm.
<u>Cypraea cernica</u> <u>tomlini</u> (New Caledonia, Loyalty Islands, Phoenix Group)	Bold, large, clear-cut	Well developed, strong, emerging well onto lip	29.2 mm.
<u>Cypraea cernica</u> <u>marielae</u> (Maui, Hawaiian Islands)	Well defined, short, moderately occupying base	Bold, thickening interstices broadening anteriorly	36.1 mm.
<u>Cypraea cernica</u> <u>prodiga</u> (New South Wales)	Strong, 14 teeth on columella, 6th or 7th the shortest	Strong, flattened ridges extending across 3/4 of lip	30.1 mm.
<u>Cypraea cernica</u> <u>percomis</u> *)			

*) Iredale, 1931: unverified and questionable species based on a single specimen from Sydney Harbor dredging.

goon, Oahu (21°17' N. Lat., 157°54' W. Long.). The Maui specimens were dredged from a mud and coral-rubble substrate, the Oahu specimens from sand and coral-rubble.

The type locality of the new subspecies is off Maui, Hawaiian Islands (20°57' N. Lat., 156°47' W. Long.).

Because of the great ocean depths surrounding the Hawaiian Archipelago, it is felt that this natural population is sufficiently removed and isolated from its other related races to establish it as a form maintaining constant morphological characteristics which clearly separate it from its known conspecific units.

Cypraea cernica marielae Cate,
new subspecies

Shell large, solid, pyriformly ovate; narrowing anteriorly, base and sides rounded, right side margined, thickened, and distinctly pitted; aperture somewhat broad, curving acutely to the left posteriorly; posterior terminal produced, anterior collar more so. Teeth coarse, well defined, short on the columella, lengthening posteriorly; labial teeth bold, extending almost to margin. Columellar teeth angling slightly onto fossula, the fine anterior teeth crossing it, the last three becoming prominent on the in-

Cypraea cernica cernica and its Subspecies

SHELL COLOR	SHELL MORPHOLOGY
Pale yellow to whitish yellow; white spots fine, often indistinct. Chestnut marginal spots almost lacking. Base and teeth white.	Small, stunted, circular-ovate; terminal less produced, margins thickened, weakly pitted; base convex.
Ochraceous yellow, hint of darker lateral dorsal band. White spots evenly dispersed. Chestnut marginal spots less numerous. Base and teeth white.	Narrower, sub-ovate; less humped; terminals extended, margins well calloused, strongly pitted; base convex.
Ochraceous yellow, white spots more abundant, diffused, confluent. Chestnut marginal spots profuse, extending onto base; base and teeth white.	Ovate, humped, lengthening anteriorly; terminals somewhat produced, margins strongly pitted, less thickened; base prominently convex.
Yellow-ochre, white spots fine, less distinct, occasionally individually large dispersing abundantly. Chestnut marginal spots large, few or entirely lacking; base and teeth white.	Pyriformly ovate, large, heavy; terminals well produced, margin less calloused, strongly pitted; base bulbously convex.
Dull orange, texture clear, shiny; irregular white spots distributed evenly; base and teeth white.	Shell appears to be larger than the typical <u>Cypraea cernica tomlini</u> .

ner edge of the fossula. Dorsum smooth, yellow-beige, generously covered with irregularly sized white spots; mantle line of deeper color extending length of upper right dorsum; base and teeth white; large chestnut spots on left margin extend restrictedly onto base; marginal pits chestnut.

Cypraea cernica marielae is by far a much larger and heavier shell, more pyriform than ovate, having coarser teeth, and with fewer chestnut marginal spots than C. cernica tomlini, but more than found on the specimens of C. cernica ogasawarensis. Its extremities are more produced and sharpened, its anterior terminal ridge is

less oblique and much more prominent, and the aperture broader and more recurved than either of the other subspecies. (See Table 1)

[Topotypes of "Cypraea tomlini tomlini" (leg. A. W. Emerson, Baker Island, Nov. 6, 1923; BPBM No. 69198) and "C. tomlini ogasawarensis" (leg. Jay Savory, Hana, Bonin Islands) in the collection of the Bernice P. Bishop Museum, Honolulu, were kindly made available for this comparative study by Mr. Edwin H. Bryan, Jr., and Dr. Yoshio Kondo.]

The name given this new subspecies is used to honor Mrs. Mariel King of Honolulu,

Table 2: Measurements of Types of *Cypraea cernica marielae* CATE, subspec. nov.
Measurements in millimeters

	Length	Width	Height	Location
Maui Specimens:				
Holotype	37.0	23.3	18.5	B. P. Bishop Museum
Paratype 1	35.5	24.8	19.0	C. N. Cate Collection
Keehi Lagoon				
Specimens:				
Paratype 2	27.4	18.9	19.0	C. S. Weaver Collection
Paratype 3	20.1	14.4	10.2	C. S. Weaver Collection
Paratype 4	14.4	8.8	7.3	C. S. Weaver Collection
Paratype 5	23.0	15.5	12.0	Mariel King Collection
Hypotype 1	21.2	15.3	11.4	Dr. T. Richert Collection
Hypotype 2	19.0	13.3	10.0	Dr. T. Richert Collection
Hypotype 3	19.6	13.3	10.0	R. P. Gage, Jr. Collection
Hypotype 4	17.6	12.0	9.0	R. P. Gage, Jr. Collection
Hypotype 5	30.8	22.2	16.8	Dr. C. M. Burgess Collection
Hypotype 6	19.2	14.0	10.0	Dr. C. M. Burgess Collection
Additional Record:				
[Beach specimen collected at Pomaluu, Oahu]				
Hypotype 7	30.3	21.3	17.0	Dr. C. M. Burgess Collection

whose devotion to conchology made possible the Pele Expedition, a segment of which involved the dredging of the Maui-Lanai-Molokai triangle where the first shells of this subspecies were taken.

The holotype will be deposited in the Bernice P. Bishop Museum, Honolulu, Hawaii, where it will bear the catalog number 212711.

An interesting feature of shell size variation is apparent in *Cypraea cernica cernica* that should be kept in mind where shell identification is involved. A detailed treatment of geographical variation is not feasible here, but it is interesting to note that in the study of *C. cernica cernica*, available adult shells range from 21.2 mm. to 27.5 mm., while those of *C. cernica marielae* vary from 20 mm. to 37 mm. A juvenile specimen of the new subspecies, well approaching adulthood, measures 14.4 mm. (See Table 2)

The distance between the two Hawaiian habitats (Maui and Oahu) is probably insuf-

ficient to separate these two populations. They are probably nothing more than intrapopulation variants. It is felt that the morphological variation shown is strictly non-inherited. The type specimens considered here seem to represent the end of a cline whose character gradient sets them apart as the representatives of this new geographical subspecies.

Not having large series of these shells for study precludes ascertaining definite size categories for the different subspecies. Generalization must therefore be considered in the light of their size relationships with one another until more information about their development becomes available. Whether the Maui and Oahu populations should be separated subspecifically will have to be determined eventually on the basis of collections made in the intermediate area.

Additional dispersal data and experimental evidence will be necessary to place these sympatric populations of *Cypraea cernica marielae* into anything greater than inter-



Figure 1

Figure 2

Figure 1a

Figure 2a



Figure 3

Figure 4

Figure 5



Figure 3a

Figure 4a

Figure 5a

Figure 1, 1a: *Cypraea cernica marielae* CATE, subsp. nov., Holotype

Figure 2, 2a: *Cypraea cernica marielae* CATE, subsp. nov., Paratype 1

Figure 3, 3a: *Cypraea cernica cernica* SOWERBY

Figure 4, 4a: *Cypraea cernica tomlii* SCHILDER

Figure 5, 5a: *Cypraea cernica ogasawarensis* SCHILDER

grading forms. For this reason the taxonomic status of the type subspecies shall for the present represent both Hawaiian shell populations, from Maui and from Keehi Lagoon, Oahu.

It is important to have the measurements of known specimens a matter of record. However, it is impossible to set a size criterion for *Cypraea cernica marielae*, as the size distribution of the paratypes and hypotypes is significantly variable. An average of these variations seems only to develop confusion. The value of the species does not depend so much on its shell size as it does on its structure, the treatment of its speciation through isolation, and its subsequent morphological evolution based upon local ecological influences. *C. cernica marielae* adequately displays the taxonomic characters of isolation and morphological change to warrant its recognition as a new subspecies.

Appreciation is expressed to Mrs. Mariel King for sponsoring the Pele Expedition; to Clifton S. Weaver for recognizing these shells in the Maui dredge hauls as new to the Hawaiian fauna, and for his helpful assistance in assembling the essential facts in

this study; to Dr. Alison Kay, Dr. A. Myra Keen, and Dr. Rudolf Stohler for their suggestions and encouragement; to Else Keller for translations of source material, and to Mr. and Mrs. John Q. Burch, Ray Summers, and others for their cooperation in the preparation of this paper. The photographs are by Mr. Lowell Weymouth.

LITERATURE CITED

- Allan, Joyce
1956. Cowry shells of world seas.
- Iredale, Tom
1935. Australian cowries. *The Australian Zoologist*, Vol. VIII, Pt. II.
-----, -----
1939. *Ibid.*, Vol. IX, Pt. III, Pl. XXVII, figs. 7, 8.
- Schilder, F. A., and M. Schilder
1938. Prodrôme of a monograph on living Cypraeidae. *Proc. Mal. Soc. Lond.*, vol. 23, pp. 119-231.
-----, -----
1944. Westpazifische Cypraeacea von den Forschungsreisen des Prof. Dr. Sixten Bock. *Arkiv för Zoologi*, (Stockholm), vol. 36A, no. 2, pp. 22-23.

The Subfamily Drupinae (Gastropoda) in the Eastern Pacific

by

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The living members of the Drupinae are essentially inhabitants of shallow tropical Indo-Pacific waters, often occurring on coral reefs.

The genus *Drupa* Röding in Bolten, 1798, type (designated by Rovert, 1899), *Drupa morum* Röding in Bolten [= *Murex neritoides* Gmelin, 1791, p. 3537 (not Gmelin, p. 3559; not Linnaeus, 1767) = *Ricinula horrida* Lamarck, 1816 = *Ricinella violacea* Schumacher, 1817], includes low spired, spiny shells, the columella plicated or wrinkled. The interior of the outer lip bears strong denticles or plications which are arranged in groups of two or three, *Sistrum* Montfort, 1810, type *Sistrum album* Montfort

[= *Murex ricinus* Linnaeus], is relegated to the synonymy of *Drupa*.

Morula Schumacher, 1817, type, *Morula papillosa* Schumacher [= *Drupa uva* Röding in Bolten], includes biconic shells which are generally smaller than *Drupa* and are nodosely sculptured. The denticles inside the outer lip are not grouped. This genus is represented in the Recent fauna of the eastern Pacific on the outermost islands from which two forms have been reported, *Morula uva* Röding in Bolten and *M. uva aspera* Lamarck. Two species, with elongated shells, which occur along the mainland of the eastern Pacific have been referred by some authors to *Morula*. These were des-

cribed as Ricinula ferruginea Reeve and Buccinum lugubre C. B. Adams. The latter one ranges north to southern California.

Drupa is represented in the Recent fauna of the eastern Pacific only at islands far offshore (Galapagos Islands and Clipperton Island). Two species have been reported, Drupa morum Röding in Bolten, D. ricina Linnaeus and D. ricina form albolabris Blainville.

Fossil forms referred to "Ricinula" or "Sistrum" have been reported from Europe and the East Indies, from beds of Paleocene or Eocene age, but I have not seen specimens. An illustration of one Eocene species, "Ricinula (Sistrum) ringens" Deshayes does not closely resemble typical Drupa or Morula. So far as has been ascertained from a perusal of the literature, typical Drupa occurs from Pliocene to Recent.

No species has been recorded under the genus name Drupa or Ricinula among the hundreds of fossil forms described from the western Americas. However, one species from beds of Pliocene age at Coos Bay, Oregon, was described as Sistrum hannai by Howe (1922, p. 102, pl. 8, figs. 1, 5). This interesting species has been found in beds of similar age in San Benito County, California (NW-1/4, Sec. 26, T. 19S., R. 11E., M. D.B. & M.). The type specimen is a very thick, subglobose shell 66 mm. high and 53.4 mm. in diameter, with a moderately elevated spire, the exterior sculptured with subdued spiral threads which alternate in size. The interior of the outer lip bears a thick elongated node surmounted by two closely arranged denticles. No plications are observable on the columella. The shell has experienced some erosion, but there is no evidence that the columella was ever other than smooth.

The only Recent species of Drupa bearing a general resemblance to this form is Drupa iodostoma Lesson (Ricinula iodostoma Lesson, Rev. Zool., Cuvierienne, p. 355, 1840; Guérin's Mag. de Zool., Moll., pl. 58, 1842). Compared to D. iodostoma, the fos-

sil form is much larger and thicker, has a high spire, a thick outer lip, and a smooth columella. These differences are so pronounced that a new supraspecific unit may need to be proposed for "Sistrum" hannai.

In summary, the subfamily Drupinae is known to be represented in the waters of the eastern Pacific by two genera, occurring on the outer fringe of islands, and by two species referred to Morula occurring along the west American mainland. One species, referable to this subfamily but not typical of Drupa or Morula occurs in beds of middle Pliocene age in Oregon and California.

LITERATURE CITED

- Dall, W. H.
1923. Notes on Drupa and Morula. Proc. Acad. Nat. Sci. Philadelphia. Vol. 75, pp. 303-306, November 12.
- Dodge, H.
1957. A historical review of the mollusks of Linnaeus. Part 5. The genus Murex of the class Gastropoda. Bull. Amer. Mus. Nat. Hist., Vol. 113, Art. 2, pp. 77-224, September 30. (See especially pp. 128-132.)
- Howe, H. V.
1922. Faunal and stratigraphic relationships of the Empire formation, Coos Bay, Oregon. Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 14, No. 3, pp. 85-114, pls. 7-12, September 8. (See especially p. 102, pl. 8, figs. 1, 5)
- Iredale, T.
1918. Molluscan nomenclatural problems and solutions. No. 1. Proc. Malacol. Soc. London, Vol. 13, Pts. 1 and 2, pp. 28-40, September 9. (See especially pp. 38-39.)
- Keen, A. M. (In J. Q. Burch)
1945. Min. Conch. Club Southern California, No. 52, p. 10, September.
- Pilsbry, H. A., and E. L. Bryan
1918. Notes on some Hawaiian species of Drupa and other shells. Nautilus, Vol. 31, No. 3, pp. 99-102, January.



Octolasmis californiana, spec. nov., A Pedunculate Barnacle
from the Gills of the California Spiny Lobster

by

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(Plate 2)

Specimens of *Panulirus interruptus* (Randall, 1839) purchased from a local fish market were found to contain the small pedunculate barnacle *Octolasmis* attached to their gills. This discovery is of particular zoogeographic interest; for this genus, although widely distributed throughout the warm seas of the world, has not heretofore been reported from the west coast of North America.

Genus *Octolasmis* Gray, 1825

Subgenus *Octolasmis* Pilsbry, 1907

Octolasmis (Octolasmis) californiana,
spec. nov.

Deposition of types: Holotype U. S. N. M. Cat. No. 104425; Paratypes U. S. N. M. Cat. No. 104426. Additional material sent to Dr. Huzio Utinomi, Seto Marine Biological Laboratory, Wakayama-Ken, Japan.

Locality: Coastal waters of southern California and Mexico, attached to the gills and branchial chamber of *Panulirus interruptus* (Randall, 1839). Nineteen specimens were removed from the gills of two lobsters that are reported by the fish dealer to have been taken north of San Diego, California, in the vicinity of San Clemente Island (type locality; approximately 32°50' West Long.; 118°20' North Lat.). One hundred and eleven specimens were removed from the gills and branchial chambers of two additional lobsters reported to have been taken from the Gulf of California in the vicinity of Mazatlan.

Description: Capitulum ovoid in profile, laterally compressed; integument translucent, white. Valves five in number, white in color. Carina with basal portion produced into a two-pronged fork. Scutum variable, of two arms at 60° to 80° to one another; basal arm above and usually overlapping basal arm of carina. Tergum extremely variable, "U" shaped or "V" shaped; occludent arm usually less well developed or vestigial. Individuals with "V" shaped

terga occasionally have tergal arms slightly overlapping the occludent arm of scutum (Plate 2E). Mandible (Plate 2G) with five teeth; third, fourth and fifth tooth bifid, fifth tooth rudimentary; inferior angle of two strong triangular spines or points. Inner maxilla (Plate 2F) notched, spines above notch in tridentate cluster, inferior margin below the notch supporting seven spines. Outer maxilla rectangular, broadly rounded, supporting long setae along the superior and inner margins. Crest area of labrum with few scattered short bristles and a row of 10 to 13 small, sharp, triangular teeth. Palps oblong, with long setae along the superior margin and tip. Cirri densely setose; setae occurring in seven or eight pairs on the intermediate segments of the lesser curvature of the sixth cirrus, the greater curvature supporting clusters of five or six long setae at each articulation. Caudal appendage as long as the peduncle of the sixth cirrus and supporting a cluster of about seven long setae at its tip. A single mature specimen had the following articles on the rami of the cirri:

Cirrus:	I	II	III	IV	V	VI
Inner Ramus:	6	13	12	12	12	12
Outer Ramus:	6	13	12	11	11	12

Penis (Plate 2H, I) tapering gradually throughout its length, surface smooth, marked by fine closely spaced transverse folds in the cuticle, clothed heavily with long soft setae arranged single file in six longitudinal rows from slightly below the apex for approximately half its length. Apex (Plate 2I) truncate, supporting a terminal tuft of short bristles.

Size: (Holotype)

Capitulum: height, 3.39 mm.; width, 1.57 mm.; depth, 2.4 mm.

Peduncle: length, 4.2 mm.; greatest diameter, 1.15 mm.

Discussion: The species described here is very similar to *Octolasmis lowei* (Darwin, 1851). The species *O. lowei* includes a number of synonyms, several of which are based on incomplete descriptions and all of which occur on the gills and in the branchial chambers of decapod crustacea. The *O. lowei* "group or complex" has been investigated by a number of workers, including Annandale (1909), Nilsson-Cantell (1927), Hiro (1937), and more recently by Brian and Darteville (1954) and Newman (1960b). Aside from the work of Hiro (1937) which succeeded in separating *O. aymonini* from the complex, no real progress has been made, and many of the proposed synonyms are of doubtful status. The problem, at least in part, is that many of the species descriptions have been primarily concerned with the configurations of the capitular plates. Unfortunately, these structures, although fairly constant in form in free-living species, are subject to much degenerative variability and cannot be relied upon. The appendages, on the other hand, show a marked constancy of form. This fact is the basis for the synonyms and accounts for the alleged cosmopolitan distribution of *O. lowei*.

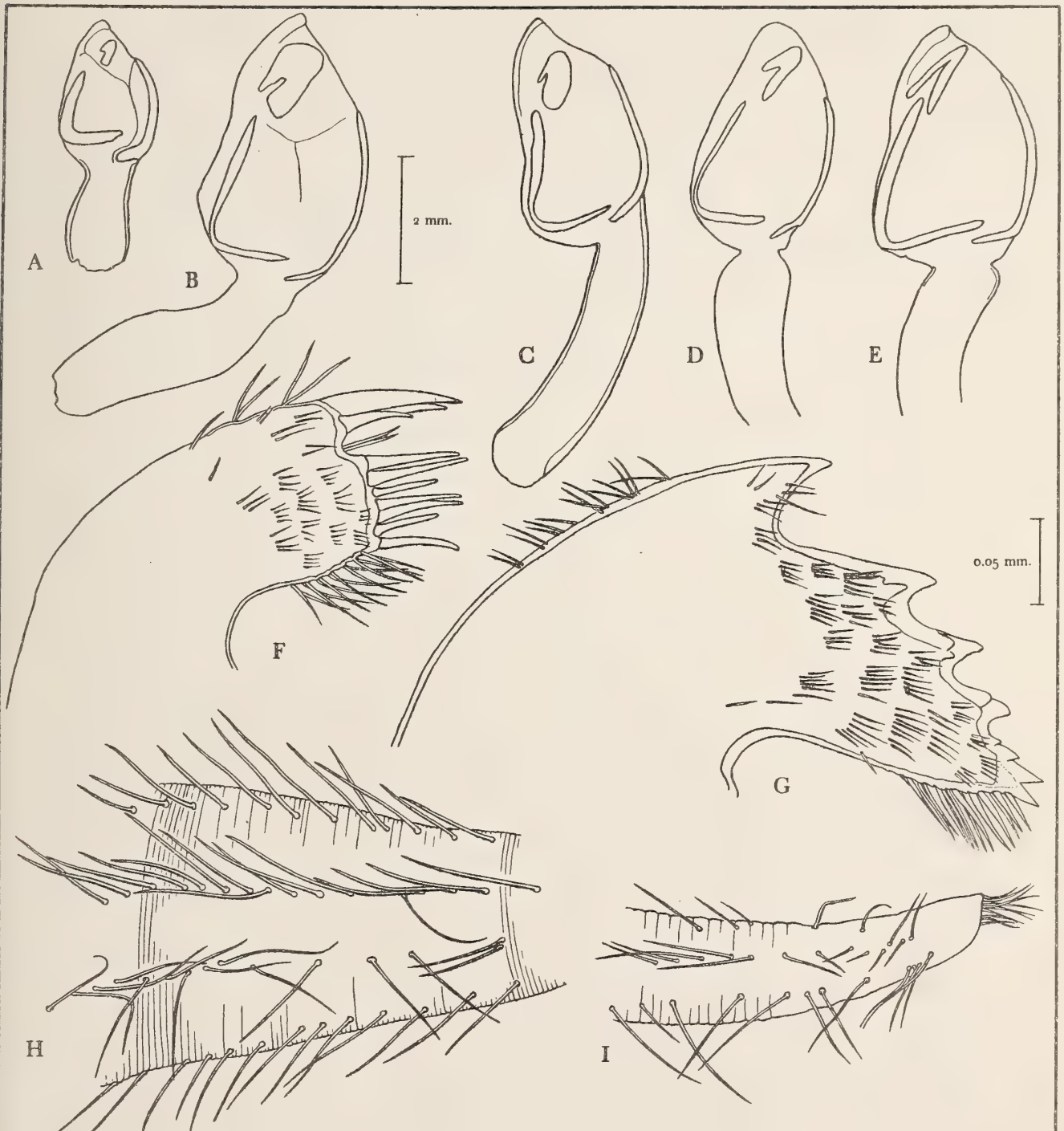
The species described here is no exception in regard to the variability in form of the valves. The terga are the most variable, yet are, except for the elongate "V" shape (Plate 2E), similar to the forms seen in *Octolasmis lowei*. The chaetotaxis and trophi are also well within the limits ascribed for *O. lowei*. The labrum has considerably more teeth than *O. lowei*, although the range of variation in *O. lowei* is not known. The structure that is most different in the two species is concerned with reproduction and is therefore believed to have considerable systematic value. I have examined specimens of *O. lowei* from Kapingamarangi Atoll in the western Pacific (Newman, 1960b) and from Kaneohe Bay, Oahu, Hawaii, in the central Pacific (Newman, 1960a; see p. 93, code no. 3). The penis of individuals from these two relatively isolated localities conforms to that described for *O. lowei*: it tapers gradually throughout its length, is finely folded transversely, is clothed sparsely with short setae, and has a tuft of fine soft bristles just below the terminal languet or apex. Under oil immersion it can be seen that the short setae that clothe the penis have

a tendency to be arranged in longitudinal rows in the distal quarter of its length. This arrangement tends to be haphazard and proximal to this region it disappears entirely. In *O. californiana*, on the other hand, the apex of the penis is truncate, the sensory tuft of bristles is terminal, and the setae clothing the penis are remarkably long and are arranged single file in six distinct longitudinal rows for at least half its length. This character is readily ascertainable and is so striking that it cannot be easily overlooked. The character is exactly the same in barnacles from both southern California and the Gulf of California, and is clearly different from the condition seen in specimens of *O. lowei* from Hawaii in the subtropical central Pacific, from Kapingamarangi Atoll in the equatorial western Pacific, and from the descriptions of *O. lowei* in the literature.

It is clear that the species described here is closely related to *Octolasmis lowei* and is on the "systematic fringe" of the *O. lowei* complex. When it becomes possible for an investigator to carefully work over representatives of *O. lowei* from different parts of the world, it may be found that the characters described here occur elsewhere. It would then seem appropriate to award the California form subspecific status.

Since this paper went to press, Dr. Huzio Utinomi of Seto Marine Biological Laboratory informed me that he has examined specimens of *Octolasmis californiana* and has compared them with two species of *Octolasmis* from Japan *O. lowei* f. *neptuni* Hiro, 1937 and *O. aymonini* (Lessona & Tapparone-Canefri, 1874). Dr. Utinomi has been kind enough to write me that *Octolasmis californiana* is clearly distinct from the Japanese forms in a number of ways, especially in regard to the structure of the penis, and that he concurs with the evidence that establishes *O. californiana* as a distinct species. I am very grateful to Dr. Utinomi for his consideration of this matter.

I would like to thank Dr. Rudolf Stohler of this Department and Dr. J. W. Durham of the Department of Paleontology for their consultation in regard to the systematic status of this barnacle. I am especially grateful to Dr. R. I. Smith for his advice and helpful criticisms and for reading the manuscript of this paper.



Octolasmis californiana, spec. nov., from the gills of *Panulirus interruptus*.

A through E, ovigerous specimens (to same scale). F, inner maxilla. G, mandible. H, central portion of penis.

Note four longitudinal rows of long setae. Rows five and six are on the opposite side and not seen here.

I, terminal portion of penis. (F through I to same scale).

LITERATURE CITED

- Annandale, N.
1909. An Account of the Indian Cirripedia Pedunculata. Mem. Ind. Mus. 2 (1): 61-137.
- Brian, A., and E. Darteville
1954. Sur un cirripède pedoncule des cotes d'Angola: *Octolasmis lowei* (Ch. Darwin). Ann. Mus. Congo Belge Tervuren. N. S., 4 (Zool.) 1: 140-152.
- Darwin, Charles
1851. A Monograph on the Sub-class Cirripedia, 1 (Ray Society, London).
- Hiro, F.
1937. Studies on Cirripedian Fauna of Japan. II. Mem. Coll. Sci. Kyoto, (B) 12(3): 221-230.
- Newman, W. A.
1960a. On the Paucity of Intertidal Barnacles in the Tropical Western Pacific. The Veliger, 2(4): 84-94.
- 1960b. Five Pedunculate Cirripeds from the Western Pacific, including Two New Forms. Crustaceana, 1(2), (in press).
- Nilsson-Cantell, C. A.
1927. Some Barnacles in the British Museum. Proc. Zool. Soc. London, Pt. 3: 743-790.

On Gondwana and the Haliotids, a Hypothesis

by

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For some time, the writer has been confronted with a rather perplexing problem of allopatric distribution in the Haliotidae. There are a number of cases in which obviously closely related species, with rather limited ranges, are separated by both ocean basins and continental land masses. In the normal study of the phylogeny of such a group, one usually has available fossil material. However, in the haliotids such fossils are rare. This is probably due to the fact that the ecological biome, shallow waters on a rock or coral substrate, does not meet the general requirements for sedimentary deposits. The few shells that are washed ashore onto a sandy beach are usually broken into fragments or are too small. With so little fossil material available, we must postulate much that we are unable to prove at this time. However, there are certain features, even with the inadequate material available, that give us a very strong indication of the phylogeny. The earliest example examined is a specimen of *Haliotis lomaensis* Anderson, from the Cretaceous of Point Loma, California, and now in the California Academy of Sciences. This tiny shell exhibits features

that leave no doubt as to the identification, and indicate that the basic characteristics of the haliotids were well and firmly established at that time. Later fossils bear this out remarkably well and may be much closer than the present species differences indicate. In other words, we are dealing with a family that was well established in the late Mesozoic, and possibly at an earlier age. With such a lack of fossil material, we must use the ones that we do have, plus the geological history, and the present distributions as we know them.

Dr. A. Myra Keen, of Stanford University, kindly made available to the writer certain publications dealing with the theory of Gondwana or Gondwanaland. As the writer is neither a geologist nor a paleontologist, much of the technical information was not fully understood. However, the general idea of land bridges was clear. Gondwana is the name that was applied to a possible land mass, large or small, that included portions of present-day South America, Africa, and south Atlantic Ocean. Some authors also included areas in the Indian Ocean as part of Gondwana, but others separated this portion

into another region, Lemuria. Some considered Gondwana to be a massive land area, while others thought that the connections were rather narrow, perhaps in the nature of an isthmus. No distinct geological time, excepting Paleozoic, was given for the original formation of this area, and the submergence was referred to by some as taking place in the Mesozoic. Others, utilizing the differences noted in fossil reptiles and amphibians, placed the sinking in the Paleozoic, as these animals would have needed land areas to move about.

Some rather interesting facts based upon this theory and our knowledge of present distribution of certain haliotids were noted. There is in the Galapagos Islands a tiny species, Haliotis dalli Henderson, which is obviously closely related to H. parva Linnaeus, of South Africa. Here we may find not only the width of the south Atlantic Ocean, but the continent of South America with the high Andes forming a barrier. No intermediate specimens are known, and except for the single beach specimen taken at Rio de Janeiro, no other haliotids have been found in South America. Incidentally, the single shell referred to above is described and figured as being quite distinct from either H. parva or H. dalli, and little is known about the species. From the geologists we learn about a remarkable bit of information that may pertain to this situation. In the vicinity of Port Elizabeth, South Africa, there is a Cretaceous formation known as the Uitenhage Series. A similar formation of like age, and also indicating shallow waters, is found in Argentina, Bolivia, and Chile. The fossils of these deposits are remarkable for their similarities.

The Canary Islands, which have a rock that is continental in character, are inhabited by a small species, Haliotis coccinea Reeve. Across Africa and the Indian Ocean we find a very close relative, the H. squamata Reeve inhabiting the shores of the Timore Sea. Here, we find a number of species that are probably closely related and which have sympatric ranges, but the closely allied H. coccinea is isolated with no similar species being found elsewhere excepting Asiatic waters.

South along the European Coast and the west coast of Africa, we find the Linnaean Haliotis tuberculata, with ranges south to

the Gold Coast. In Natal and portions of South Africa on the Indian Ocean, we find the small H. speciosa Reeve, which has a similar shell. Here the main mass of the African continent forms a barrier.

We might consider other species, such as the obvious relationship of Haliotis quecketti Smith of Natal and H. brazieri Angas from New South Wales. Perhaps the classical example is the discovery of H. sanguinea Hanley living in West Australia, with no intermediate localities known other than the basic range in South Africa. The remarkable facts about this distribution are the limited ranges of these closely allied species, and the lack of intermediate stations.

The three theories dealing with continental areas may be referred to as "Continental Stability", "Continental Drift", and "Land Bridges". The first assumes that the ocean basins and continents have always been more or less as they are today. It is impossible for the writer to accept this theory, for when one is standing on a marine deposit that is now elevated six thousand feet above the present sea level, there is nothing to indicate stability. This is especially true when one learns that both prior to and after this marine submergence there were periods when the region was above the sea. The idea of the breaking apart of a major land mass and the drifting of the continents on the magma to their present position is likewise difficult to accept because of these same fossil deposits and their sequence. The very formations found in Arizona and Utah, marine, freshwater, land, more marine, and so on, lend the theory of land bridges, submergences and elevations, what appear to be factual data. We also know that certain connecting links of the not too distant past are lost. Probably the most noted is that land connection between Siberia and Alaska which is now beneath the sea. Panama appears to have been below and above the sea a number of times. Thus it is not difficult to picture major elevations and submergences in the geological past.

In view of this information it appears reasonable to assume that this might have happened. Sometime in the Paleozoic there existed perhaps a continental mass, perhaps an isthmus, perhaps a series of islands in a shallow sea that extended around the southern hemisphere. Such a region would fur-

nish the shallow water with coral or rock for the haliotids. As geological changes altered the situation, certain portions of the range were separated by non-habitable regions. This left isolated populations which survived, perhaps in the original stage, perhaps altered somewhat. Perhaps we have several basic species represented in this situation, although the majority appear to belong to the genus or subgenus *Padollus*. Perhaps we have had several such distributions and separations in the past geological time.

The argument has been advanced that such distributions are the result of planktonic drift. If this is true, where are the intermediate stations? And also, if this is true, then the free-swimming stage must last far longer than is now known, since the distances are measured in the thousands of miles, and often against strong currents.

In conclusion, let us briefly review the known facts that we have concerning both Gondwana and the Haliotidae. Gondwana is supposed to have occupied portions of present-day South America and Africa, as well as the south Atlantic Ocean. This area was presumed to have submerged or was submerging during the late Paleozoic or Mesozoic. Such major geological changes take years to complete. This theory is based upon similarities of plant and invertebrate fossils and differences in terrestrial vertebrate fossils. We may trace the haliotids

back in geological history to the Cretaceous. We find certain species, that are obviously related to each other, living in isolated areas of what would have been Gondwanaland. Thus, if we accept the theory of Gondwana, it would be logical to assume that these species, or a common ancestor species, lived along the shores of this lost region. As the region sank into the depths, these isolated populations remained, and today represent relics of that past distribution.

Or perhaps this is all in error, and we are actually confronted with some remarkable cases of parallel evolution.

LITERATURE CITED

- Camp, Charles L.
1952. *Earth Song*. Univ. Calif. Press.
- Hinds, Norman E. A.
1952. *Evolution of the California Landscape*. Bull. 158, Div. of Mines, State of California.
- McKee, Edwin D.
1948. *Ancient Landscapes of the Grand Canyon Region*, Ed. 18; Sun Printers, Flagstaff, Arizona.
- Schuchert, Charles
1932. *Gondwana Land Bridges*. Bull. Geol. Soc. of America, Vol. 43.
- Willis, Bailey
1932. *Isthmian Links*. Bull. Geol. Soc. of America, Vol. 43.

Gastropods from Clipperton Island

by

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This is the third contribution in a series of papers (see: *The Veliger*, vol. 1, no. 4, pp. 32-34; vol. 2, no. 4, pp. 94-95, pl. 22) dealing with the Indo-Pacific West American molluscan fauna of Clipperton Island, an isolated coral atoll in the eastern Pacific, about 670 miles southwest of Acapulco, Mexico.

Specimens on which this paper is primarily based were collected by the junior au-

thor with the assistance of other personnel participating in 1956 and 1958 Clipperton Island investigations by the Scripps Institution of Oceanography. Collections were taken from the beach, from the reef flat, and (by SCUBA diving) from off the edge of the reef flat to water depths of about 40 meters (130 feet). Conrad Limbaugh of the Scripps Institution of Oceanography, recently lost in a tragic diving accident, collected specimens

below 20 meters (65 feet). Specimens collected from the lagoon reflect past marine conditions when oceanic waters had free access.

Occurrences of all known Clipperton representatives of the families Neritidae, Littorinidae, Hipponicidae, Janthinidae, Tonniidae, Cassididae, Terebridae, Mitridae, Buccinidae, Harpidae, Cymatiidae, Bursidae, Thaididae, and Coralliophilidae are listed below. The families Cypraeidae and Conidae were treated in the previous two articles of the series.

Family NERITIDAE

Nerita plicata Linnaeus, 1758

Living specimens common near upper limit of high tides on north side of island; clustered on light grayish, superficially bare (though probably algae-covered), rock surfaces protected by eroded crevices and permanently settled boulders of beach rock; associated with lowest shoreline occurrences of Littorina schmitti.

Family LITTORINIDAE

Littorina schmitti Bartsch and Rehder, 1939

Living specimens abundant on all sides of island on protected rock surfaces similar to those which support Nerita plicata but located higher on shore; reached by spray from high tide waves.

Family HIPPONICIDAE

Hipponix antiquatus (Linnaeus, 1758)

Few abraded shells in beach deposits and as fossils in shallow water deposits on north side of lagoon.

Hipponix fimbriata Bartsch & Rehder, 1939

Abundant living specimens among coral boulders of inner part of intertidal reef flat, at outer edge of reef flat, and to depths of at least 40 meters (130 feet), the lower limit of collections.

Hipponix pilosus (Deshayes, 1832)

Distribution similar to that of H. fimbriata.

Family JANTHINIDAE

Janthina janthina (Linnaeus, 1758)

Pelagic, few dead specimens on beach.

Family TONNIDAE

Malea ringens (Swainson, 1822)

Few dead specimens and fragments of specimens on beach, south and west sides of island.

Family CASSIDIDAE

Cassis (Cypraecassis) tenuis Wood, 1828

Few dead specimens and fragments of specimens on beach, east and northwest sides of island; possibly responsible for predation on common sea urchin, Triptoneustes gratilla, many tests of which bear single small perforation on side or upper surface (Limbaugh, verbal communication).

Family TEREBRIDAE

Terebra crenulata interlineata

Deshayes, 1859

Fresh but dead specimen on patch of coral sand off northwest side of island at depth of about 21 meters (70 feet); few abraded shells in beach deposits on same side of island.

Family MITRIDAE

Mitra edentula Swainson, 1823

Few abraded shells on shore.

Mitra effusa Swainson in Broderip, 1836

Several moderately fresh shells in beach deposits.

Mitra ferruginea Lamarck, 1811

Few abraded and several fresh shells in beach deposits on all sides of island.

Mitra cf. M. lignaria Reeve, 1844

Several abraded shells in beach deposits.

Mitra papalis (Linnaeus, 1758)

Few shells, some fresh and some severely abraded, in beach deposits on all sides of island.

Family BUCCINIDAE

Cantharus sanguinolentus (Duclos, 1833)

One abraded shell in beach deposits on west side of island.

Family HARPIDAE

Harpa gracilis Broderip & Sowerby, 1829

Several abraded specimens in storm wave debris on north side of island.

Family CYMATIIDAE

Cymatium nicobaricum

(Röding in Bolten, 1798)

One fresh shell in beach drift on northwest side of island.

Cymatium vestitum (Hinds, 1844)

Fresh shells fairly common on beaches on north and west sides of island.

Family BURSIDAE

Bursa cruentata (Sowerby, 1841)

Living specimens among coral and coral debris off north side of island at depths exceeding 10 meters (35 feet); abraded specimens uncommon on shore except in storm wave debris on north side of island.

Bursa granularis affinis

(Broderip & Sowerby, 1833)

Living specimens common among coral boulders of reef flat on south side of island and off edge of reef flat on north side of island to depth of about 12 meters (40 feet); abraded specimens abundant on shore on all sides of island.

Bursa granularis (Röding in Bolten, 1798)

Moderately fresh shells generally common in shore deposits.

Family THAIDIDAE

Nassa francolinus (Bruguère, 1789)

Beach-worn specimens fairly common on north and south sides of island.

Drupa morum Röding in Bolten, 1798

One slightly abraded specimen in storm-washed area on north side of island.

Drupa ricina (Linnaeus, 1758)

Abraded specimens in beach deposits on north side of island and on sand patch off northwest side of island at depth of about 21 meters (70 feet).

Drupa ricina albolabris (Blainville, 1832)

Abundant living specimens among boulders and coral debris of reef flat, especially on seaward parts of flat; common living specimens in coral and coral debris off outer edge of reef flat to depth of at least 40 meters (130 feet), the lower limit of collections; living specimens generally clustered on coral rocks exposed to harsher wave action than those on which Morula uva occurs in comparable abundance.

Morula uva (Röding in Bolten, 1798)

Abundant living specimens on reef flat; common living specimens off outer edge of reef flat to depth of about 20 meters (65 feet).

Morula uva aspera (Lamarck, 1816)

Occurrence cited by Keen, 1958 (Sea Shells of Tropical West America, Stanford University Press).

Thais haemastoma biserialis

(Blainville, 1832)

Few abraded specimens in beach deposits.

Thais planospira (Lamarck, 1822)

Few living specimens under coral boulders along inner edge of reef flat on north side of island.

Thais speciosa (Valenciennes, 1832)

Several abraded shells in storm wave deposits on north side of island.

Purpura patula pansa Gould, 1853

One living specimen from under coral boulder on inner part of reef flat, north side of island.

Family CORALLIOPHILIDAE

Coralliophila violacea (Kiener, 1835)

Living specimens common on living coral (Porites) and in coral debris on outer part of reef flat and offshore at least to depth of 18 meters (60 feet).

Magilus robillardi Lienard, 1870

Abraded shells from beach deposits.

Quoyula madreporarum (Sowerby, 1834)

Living specimens imbedded in coral (Pocillopora) on reef flat and off edge of reef flat to depth of at least 18 meters (60 feet).

A Pycnogonid Infestation of *Mytilus californianus*

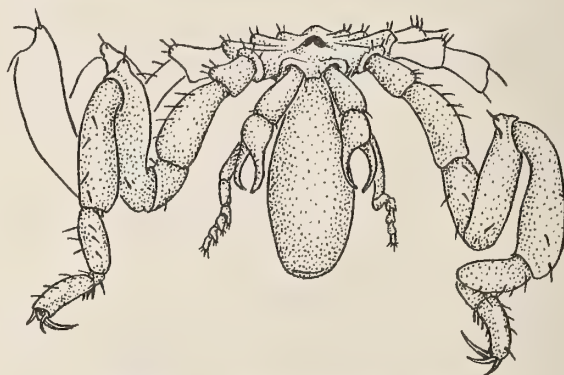
by

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(Plate 3)

Thirty-two specimens of Mytilus californianus Conrad were collected by the authors at Duxbury Reef (37°53'30" N., 122°42' W), Marin County, California, on February 20, 1960. Upon examination, 16 of the 32 mussels exhibited infestation by the pycnogonid Achelia chelata (Hilton, 1939) (= Ammonothea euchelata Hedgpeth, 1940). A total of 89 pycnogonids were counted, the incidence ranged from one to 21 parasites per host. The latter specimen is illustrated in plate 3, fig. 1. Immature and apparently mature parasites of both sexes were represented. Obvious destruction to the host's ctenidial and gonadal tissue was evident (see plate 3, fig. 2). Damage to the visceral mass, foot and palps was also apparent in several mussels. In the specimen exhibiting the greatest amount of damage, there was a complete loss of ctenidia and the major portion of mantle and gonadal tissue, accompanied by apparent atrophy of the entire animal. It is of interest to note that a group from Chico State College under the direction of Dr. Rodgers examined over 50 specimens of Mytilus californianus from Tomales Point, Marin County, on May 1, 1960, and found no pycnogonids. They did, however, encounter a high incidence of the pea crab Fabia subquadrata Dana within the bivalves. This commensal was not encountered in the mussels examined by us. Another commensal pea crab, Pinnotheres latissimus Bürger, was encountered by Ohshima (1935) in Japan

during his examinations of Paphia. In this latter case the presence of these crabs seemed in no way to interfere with the parasitism by pycnogonids mentioned later in this report.



Textfigure 1: Achelia chelata (HILTON)
Frontview of Holotype of Ammonothea euchelata HEDGPETH. Reproduced with permission from J. W. Hedgpeth, Jour. Wash. Acad. Sci., 1940, figure 1, page 85.

Achelia chelata was reported by Hilton (1939) as occurring on the central California Coast. Hedgpeth (1940) collected a male of this species (text fig. 1) from Bugula at Pescadero, San Mateo County, California. An occurrence has also been recorded from Moss Beach, San Mateo County, California (S. F. Light, et al., 1957). Ziegler (1960) collected a specimen of A. chelata on the rock substrate under a Mytilus bed at Duxbury Reef, Marin County, California.



Figure 1



Figure 2

See Text for Explanation

Linné (1767) was the first to cite a pycnogonid-lamellibranch relationship. He accepted J. G. König's observation on an Icelandic specimen, Phalangium grossipes Linné, and stated: "... Mytilorum testasque penetrat et exhaurit." Fabricius (1780) and Dohrn (1881) refuted the possibility of such an occurrence. Upon examination of the Linnean specimen, Calman (1929) referred it to the common species Phoxichilidium femoratum Rathke and was of the opinion that, in all probability, König was mistaken.

Various other authors have reported incidental associations of lamellibranchs and pycnogonids. Specimens of Pycnogonum littorale Stroem have been reported by Hoek (1881) as living on the shells of Ostrea from the banks of the Scheldt near Wemeldinge, South West Netherlands. Ammothaea longipes Hodge was found on mussels attached to the hull of a coalboat at Arcachon, France, by Cuenot (1921). Hilton (1915) collected Halosoma viridintestinalis Cole from amidst the mussels at Laguna Beach, California. While collecting at Shark Island, Port Jackson, Australia, Flynn (1918a, 1919b) obtained a single male specimen of Halosoma haswelli Flynn from between the mussels (Brachyodontes hirsutus Lk.) and a female specimen of Ammothaea australiensis Flynn among mussels and sponges.

A parasitic association between a lamellibranch and a pycnogonid was reported by Ohshima in 1927. Specimens of Tapes (= Paphia) philippinarum Adams and Reeve from Fukuoka, Japan, were found to be hosts for a new genus and species of pycnogonid, Nymphonella tapetis Ohshima (1927a). The immature parasites were found attached to the ctenidia, visceral mass, and mantle of the host. Later, Ohshima (1927b) recorded the same pycnogonid as occurring in Protothaca jedomensis Lischke from the same locality. The first adult specimens of Nymphonella tapetis, two females, were collected from the sandy bottom at low tide near Fukuoka in 1932 (see Ohshima, 1933). Two adult males of the species were obtained, one from the sandy bottom of the mouth of Tomioka Bay, Amakusa, and the other from the bottom off Kadzusa, Shimabara Peninsula, Japan. These adult forms were assumed by Ohshima (1935) to be free living. Definite fluctuations between a high incidence (March to June) and a low incidence of host infestation (August to September) led

Ohshima (1937) to state that in all probability the fully developed young leave the mantle cavity of the host between the end of May and middle of June to begin their free life as adults in the sandy substrate. Le Calvez (1950) reports Nymphonella tapetis from the Mediterranean as a free-living form. Another species N. lambertensis was described by Stock (1959). The pycnogonid was dredged from the sandy bottom in 15 meters of water at Lambert's Bay, north of Cape Town, South Africa. Stock also considers Calvez' Mediterranean form in some respects as intermediate between Ohshima's Japanese and his South African species.

Pycnogonids have also been found parasitic upon gastropods. Merton (1906) found a new species, Nymphon parasiticum, parasitic upon the opisthobranch Tethys leporina Linné from Naples. Ohshima (1933) relates another case of parasitism on an opisthobranch. A specimen of Armina variolosa Bergh, collected at Hojo, Province of Awa, was found to be infested by 40 young pycnogonids of the genus Ammothaea. An interesting case of parasitism, reported by Stock (1959) of the pycnogonid Hannonia upon the polychaete Audovina australis from Langebaan Lagoon, South Africa, is the first instance in which such a relationship has occurred except for vague indications of similar incidences in Helfer and Schlottke (1935).

As far as the authors can ascertain, this is the first time the parasitism of Mytilus californianus by Achelia chelata has been reported. This occurrence is also the third such pycnogonid-lamellibranch relationship to be recorded.

ACKNOWLEDGMENTS

We would like to express our sincere appreciation to Dr. Joel W. Hedgpeth for his generous aid in supplying literature and suggestions. We also wish to extend our gratitude to Mr. Charles E. Crompton of the California Academy of Sciences and to the Academy itself for their willing help in making possible the photographic material supplementing this paper.

LITERATURE CITED

- André, M., and E. Lamy
1938. Pycnogonides parasites de mollusques. Journ. Conchyl., 82: 326-331.

- Calman, W. T.
1929. The Pycnogonida. Journ. Quekett. Microsc. Club., 16: 95-106.
- Calvez, J. Le.
1950. Un Pycnogonide nouveau pour la Méditerranée: Nymphonella tapetis Ohshima. Arch. Zool. Exp. et Gen., 86(3): 114-117.
- Dohrn, A.
1881. Die Pantopoden des Golfes von Neapel. Fauna u Flora G. Neapel, III Monogr., p. 217.
- Fabricius, O.
1780. Fauna Groenlandica, p. 231.
- Flynn, T. T.
1918a. On a pycnogonid of the genus Halosoma from New South Wales. Proc. R. Soc. Tasmania, p. 11.

1918b. Two new Australian Pycnogonida. Proc. R. Soc. Tasmania, p. 95.
- Hedgpeth, J. W.
1940. A new pycnogonid from Pescadero, California, and distributional notes on other species. Journ. Washington Acad. Sci., 30(2): 84-87.
- Helfer, H. and E. Schlottke
1935. Pantopoda. Bronns Kl. & Ordn. Tierreichs., 5:4:2:2, p. 198-201.
- Hilton, W. A.
1915. Pycnogonids collected during the summer of 1914 and 1915 at Laguna Beach. Pomona Journ. Ent. and Zool. 7: 69-205.

1939. A preliminary list of pycnogonids from the shores of California. Pomona Journ. Ent. and Zool., 31(2): 27-35.
- Hoek, P. C. C.
1881. Nouvelles études sur les Pycnogonides. Arch. Zool. Exp. et Gen., t. g., p. 522.
- Light, S. F., et al.
1957. Intertidal invertebrates of the central California coast. Univ. Calif. Press, Berkeley, p.208.
- Linné, C.
1767. Syst. Nat., ed. 12, p. 1027.
- Merton, H.
1906. Eine auf Tethys leporina parasitisch lebende Pantopoden Larve (Nymphon parasiticum n. sp.) Mittheil. Zool. Stat. Neapel. 18 BC., p. 136-141.
- Ohshima, H.
1927a. Nymphonella tapetis n. g. n. sp., A Pycnogon parasitic in a bivalve. Annot. Zool. Japon., III: 257-263.

1927b. Pknogono parazite vivanta en Bivalvo. Bult. Sci. Fakult. Terkult. Kjûsu Imp. Univ., 2(5): 366-378.

1933a. The adult of the bivalve-infesting pycnogonid, Nymphonella tapetis Ohshima. Annot. Zool. Japon., 14(1): 53-60.

1933b. Young pycnogonids found parasitic on nudibranchs. Annot. Zool. Japon., 14(1): 61-66.

1935. A further note on Nymphonella tapetis: the egg-carrying mature male. Annot. Zool. Japon., 15(1): 95-102.

1937. The life history of "Nymphonella tapetis" Ohshima. 12 Congress Int. de Zool. Lisbonne, 1935, p. 1616-1626.
- Stock, J. H.
1959. On some South African Pycnogonids of the University of Cape Town Ecological Survey. Trans. Roy. Soc. South Africa, 35(5): 549-567.
- Ziegler, A. C.
1960. Annotated list of Pycnogonida collected near Bolinas, California. The Veliger, 3(1): 19-22.



Annotated List of Pycnogonida collected near Bolinas, California

by

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The collection of pycnogonids discussed below was made July 2 - 23, 1958, while the author was enrolled in the University of California summer course in invertebrate zoology given by Drs. Ralph I. Smith and Cadet Hand at Bolinas, in Marin County. Duxbury Reef and other rocky intertidal areas within a mile or so of the village of Bolinas were most extensively investigated. Two trips were made to a rocky, exposed shore on the Rodriguez Ranch about seven miles south-east of Bolinas, and one trip was made to the Bodega Harbor jetty at Dillon Beach, Sonoma County, about 30 miles north-north-east of Bolinas. A total of almost 300 pycnogonids was obtained during this study. Most of the specimens were collected by the author, but a few, mostly from hydroids, were donated by other students in the class. The specimens were killed by immersion in fresh water, and preserved in 9:1 70% alcohol-glycerine solution. The collections and field notes were donated to the museum of Pacific Marine Station at Dillon Beach. The author wishes to thank Dr. Joel W. Hedgpeth, Director of Pacific Marine Station, for confirmation of identifications and assistance in preparing this paper.

This is the first list of Pycnogonida from the Bolinas area. Twelve species were listed from Dillon Beach by Hedgpeth (1951), some 27 miles north-north-east of Bolinas; of the 11 species here recorded from Bolinas, three are as yet unknown from the Dillon Beach area.

Family PHOXICHILIDIIDAE Sars, 1891

Genus PHOXICHILIDIUM

Milne - Edwards, 1840

Phoxichilidium femoratum (Rathke), 1799

Only one specimen of this species was collected: a female on hydroids at -2 ft. out on Duxbury Reef. This species, as other members of the family, bears chelae in the adult state, and the chelae are situated on chelifores of such a length that the chelae may easily be used to transfer food directly into the mouth of the animal.

Genus HALOSOMA Cole, 1904

Halosoma viridintestinale Cole, 1904

Although this species is reported by Hedgpeth (1951) as being abundant on the "eel grass" (Zostera) and among hydroids of the shallow waters of Tomales Bay and as also occurring in the rocky area north of Dillon Beach, only one specimen was secured in the Bolinas area. This was a female found on the girdle spines of a chiton, Mopalia muscosa, collected on the rocky flat just west of Duxbury Reef at about +2 or +3 feet. The absence of Zostera in the vicinity of Bolinas may account for the apparent scarcity of H. viridintestinale there. Beds of the "surf grass", Phyllospadix, fairly common on the more exposed rocky shores around Bolinas, were searched unsuccessfully for this species.

Genus ANOPLDACTYLUS Wilson, 1878

Anoplodactylus sp.

Five specimens of a small white member of this genus were taken from three lots of hydroids collected at about -1 foot well out on Duxbury Reef. Three of the animals are apparently immature, with the greater portion of the last pair of legs yet unformed, and the abdomen projecting beneath them rather than above them as in the adults. The remaining two specimens are males since they possess ovigers and are at least sub-adult, to judge from the appearance of the ovigers. All pairs of legs are fully formed. This form bears a fairly close resemblance to Anoplodactylus erectus Cole, but has a narrower, less bulbous proboscis.

Family AMMOTHEIDAE Dohrn, 1881

Genus ACHELIA Hodge, 1864

Achelia chelata (Hilton), 1939

A single large adult was taken with six Pycnogonum stearnsi on rock substrate under one or two square feet of Mytilus bed at about +4 feet on Duxbury Reef. This species

is reported as occurring "on Bugula, Pescadero; Moss Beach, San Mateo County" (Light, et al., 1954, p. 208). The point of collection was at least 20 to 30 or more feet from any noticeable hydroid colonies, but several small anemones of the genus Anthopleura were scattered through the mussel bed in the immediate area.

Parasitism of mussels by this species, as reported elsewhere in this journal by Benson, was not noticed during this study, although mussels were used as subjects for the study of molluscan ctenidia by the class.

Achelia gracilipes (Cole), 1904

This small white species was collected only once on the hydroids at Duxbury Reef but was very common, especially on Sertularia, at Rodriguez Ranch beach. Surprisingly, two were also found on the underside of rocks on the Bodega Harbor breakwater, apparently not in close association with hydroids. Half of all of the specimens collected were immature. The scarcity of this form at Bolinas proper is difficult to explain. Hedgpeth's (1951) account of the species also seems to give indications of a spotty distributional pattern.

An immature pycnogonid found on Gracilaria dredged from -5 feet in front of the Coast Guard Station in Bolinas Lagoon is possibly referable to this species. This specimen, incidentally, was the only pycnogonid collected from the lagoon. A very similar species, Achelia nudiuscula, is so far recorded only from San Francisco Bay.

Ammothella tuberculata Cole, 1904

A few specimens were found on hydroids from both the Rodriguez Ranch beach and Duxbury Reef. One specimen was taken from a Phyllospadix root mass from Rodriguez Ranch and another from under a rock on the Bodega Harbor breakwater. This form and the following species are fairly similar in appearance but may be distinguished by the more compact, almost circular, body of A. tuberculata and by the lack of long projections on its chelifore segments. The dorsal projections on the body segments may be either two or three in number and tend to be closer together and more rounded than those of Ammothella menziesi.

Ammothella menziesi Hedgpeth, 1951

Two specimens were taken among hydroids on Duxbury Reef. The body of this species appears rather spindly because of the relatively great separation of the lateral processes. Other distinguishing features are listed in the account of the preceding species. The type locality is Dillon Beach.

Genus LECYTHORHYNCHUS Böhm, 1879

Lecythorhynchus marginatus Cole, 1904

This is one of the most common species on hydroids in crevices along the rocky shore at the base of Duxbury Reef, and it also occurs in some numbers out along the reef. One was taken on hydroids at the Rodriguez Ranch beach, and seven were taken under rocks at the Bodega Harbor breakwater. The animals under rocks did not seem to be moving about but were settled in small cracks and depressions with the legs pulled in close to the body and the "knees" projecting vertically. The large series (37) from Bolinas, when alive, showed various degrees of fine red spotting along the dorsal midline of the body--some had the spotting restricted to the vicinity of the eye tubercle while others exhibited practically a solid line of red from eye tubercle to abdomen. When on Aglaophenia the thin body and the long brown-banded legs cause this animal to closely resemble its surroundings.

Family TANYSTYLIDAE Schimkewitsch, 1913

Genus TANYSTYLUM Miers, 1879

Tanystylum californicum Hilton, 1939

Many individuals of this species were found in hydroids both on Duxbury Reef and, less commonly, along the rocky shore at its base. However, only one specimen was taken at Rodriguez Ranch beach where the species seemed to be replaced on the hydroids by Achelia gracilipes.

The adults of Tanystylum californicum are generally light brown in color and have three spines on the "heel" of the propodus. The immatures (recognized as such by their apparently unjointed short ovigers which are

closely appressed to the body rather than hanging vertically) are usually whitish and have only two propodial spines. However, at least one brown specimen was collected which still retained small ovigers and two propodial spines. Also, a few immatures were noted to have three spines instead of the usual two on some of the propodi. A set of propodi from such an animal was shown to Dr. Hedgpeth, and his tentative conclusion was that the pycnogonid had only partly undergone the adult molt—all the legs not molting at the same time—and would eventually possess three spines on all propodi.

Family PYCNOGONIDAE Wilson, 1878

Genus PYCNOGONUM Brunnich, 1764

Pycnogonum stearnsi Ives, 1892

This is a relatively common species taken at all three of the main collecting localities. It is generally restricted to the vicinity of sea anemones although two or three small individuals were taken on hydroids and in a Phyllospadix root mass. They sometimes occur in clusters of six or eight individuals around a single anemone. At Doran Beach over 100 animals, including many very small individuals, were removed from three rather small rocks where they were feeding upon Metridium senile. Possibly some were also feeding on another small reddish anemone since some of the pycnogonids showed viscera of a definite pink color.

At Duxbury Reef and at Rodriguez Ranch beach Metridium was not noted, or at least did not occur so commonly, and the pycnogonids were found at the bases of the larger individuals of Anthopleura xanthogrammica, usually on a more or less sheltered side of the anemone.

Many of the animals had the proboscis shallowly inserted into a small hole in the side of the column and were apparently feeding upon body juices or bits of the anemone. The pycnogonids did not seem to be using the claws on the tips of each leg to grasp the Anthopleura, and the contact made by the proboscis appeared to be the main holding force. These observations were, however, made upon anemones which were left dry by the receding tide, and it may be that under water the pycnogonids maintain a much stronger grip with the claws to prevent them-

selves from being swept away by water currents. The occasional beds of Anthopleura elegantissima in which the anemones were tightly pressed against one another did not seem to harbor any pycnogonids.

This genus seems well adapted morphologically to its existence on sea anemones and on the underside of rocks. The legs are short and stocky for a pycnogonid, and they tend to be kept stretched out laterally. The body is rather heavy but flattened dorso-ventrally so that the animal would seem to offer little resistance to water currents when closely applied to a relatively flat surface.

Pycnogonum rickettsi Schmitt, 1934

This species is listed as subtidal (Hedgpeth, 1941) and is possibly rare or at least not frequently collected along the California coast north of Monterey. Hedgpeth (1951) lists one collected at Tomales Point in 1938. However, at Bolinas on Duxbury Reef and the adjacent rocky shore this species may be found on Anthopleura xanthogrammica at tide levels of up to +2 or +3 feet. Twenty-seven were taken in such situations in one low-tide collecting period. This species, like P. stearnsi, was found out of water on the trunks of medium- and large-sized anemones. Several individuals were observed feeding in the manner of P. stearnsi as described in the account of that species. It was also found that P. rickettsi could be collected from anemones in tide pools merely by running the fingers around the sides of the anemones until a pycnogonid was felt. There seemed to be a tendency for the pycnogonids to occur higher up on the trunks of the water-covered anemones than on the trunks of the "dry" anemones. This is possibly because of a retreat on the part of the pycnogonids to the moister basal portion of the anemones to avoid desiccation as the tide lowers.

Young of this species resemble P. stearnsi in their whitish or pale flesh coloration, but adult rickettsi appear dirty tan with a few dark brown or blackish markings on the back and legs, and they closely resemble the sand and silt which is present around the bases of the anemones.

The two species of Pycnogonum were not collected from the same individual anemone, but they were found on anemones

only a few feet apart, so it appears that in the Bolinas area, at least, the feeding habits of the two are quite similar.

LITERATURE CITED

Hedgpeth, J. W.

1941. A key to the Pycnogonida of the Pacific coast of North America. Trans. San Diego Soc. Nat. Hist., 9(26): 253-264.

-----, -----

1951. Pycnogonids from Dillon Beach and vicinity, California, with descriptions of two new species. Wasmann Jour. Biol., 9(1): 105-117.
Light, S. F., R. I. Smith, F. A. Pitelka, D. P. Abbott, and F. M. Weesner
1954. Intertidal invertebrates of the central California coast. Univ. of Calif. Press, XIV-446.

Deep Water Collecting off Guaymas, Mexico

by

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During December of 1959, while vacationing in Guaymas, Mexico, I had the privilege of spending two days aboard the General Yañez, a 65-foot shrimp trawler. During this time we used the boat exclusively to trawl for shells in water ranging in depth from 18-55 fathoms. The trawling was done in the vicinity of Cabo Haro, which is just west of the entrance to Guaymas Bay.

The trip was made possible through the generosity of Captain Xavier Mendoza of Productos Marinos de Guaymas. Besides Captain Mendoza and the author, others in the collecting party included Dr. Bruce Campbell and Todd Schowalter, also of the Conchological Club of Southern California, and Ivan Thompson of Brawley, California.

Many of the specimens are as yet unidentified, and there may be several new species to describe; however, a partial listing of those already identified will be of interest to those working in the Panamic area.

PELECYPODA

- Noetia delgada (Lowe, 1935)
Ostrea megodon Hanley, 1846
Pecten sericeus Hinds, 1845
Miltha xantusi (Dall, 1905), valves only
Echinochama californica Dall, 1903, valves only
Trachycardium belcheri (Broderip & Sowerby, 1829)
Lophocardium annettae (Dall, 1889)
Nemocardium pazianum (Dall, 1916)

GASTROPODA

- Turcica coffea Gabb, 1865, single specimen represented by apical fragment
Architectonica placentalis (Hinds, 1844)
Xenophora robusta Verrill, 1870
Natica colima Strong & Hertlein, 1937
Cymatium amictum (Reeve, 1844)
Distorsio constrictus (Broderip, 1833)
Distorsio decussatus (Valenciennes, 1832)
Maxwellia humilis (Broderip, 1833) (?)
Pterynotus inezana (Durham, 1950)
Pterynotus swanstoni Hertlein & Strong, 1951, dead specimens only
Typhis coronatus Broderip, 1833
Coralliophila hindsii (Carpenter, 1857)
Strombina subangularis Lowe, 1935
Cantharus shaskyi Berry, 1959
Cantharus mendozana (Berry, 1959), dead specimen only
Metula amosi Vanatta, 1913
Cancellaria clavatula Sowerby, 1832
Trigonostoma bullatum (Sowerby, 1832)
Trigonostoma funiculatum (Hinds, 1843)
Gemmula hindsiana Berry, 1958
Ancistrosyrinx cedonulli (Reeve, 1843)
Nefastia tuberculifera (Broderip & Sowerby, 1829)
Clavus roseolus (Hertlein & Strong, 1955)
Tenaturris verdensis (Dall, 1919)
Turricula armilda (Dall, 1908)

We were particularly happy to get four specimens of Pterynotus inezana. Perhaps it will now be possible to work out its rela-

tionship to *Pterynotus pinniger*.

The finding of the apical fragment of *Turcica caffa* further establishes this species as a resident in the Gulf of California. I now have also four intact specimens of this species reportedly taken between Guaymas and Tastiota, 80 miles to the north. Two of these are with operculum.

An incident not related to the above trawling occurred while we were in Guaymas. Early one morning Todd Schowalter and I were looking over some of the shrimp boats that had docked during the night. On one of the boats, the nets still suspended from the rigging and still dripping water — evidence

that the boat had worked off Guaymas the previous night (none of the crew was around) — I found on the deck at the bottom of the suspended nets a good (but dead) specimen of *Cancellaria cooperi* Gabb, 1865. Although this is only circumstantial evidence of the occurrence of this species within the Gulf of California, we must be on the alert for more specimens of this.

Considerable work needs to be done on many of the species collected, especially the turrids. When this is completed, a check list of all the species will be published along with specific data, range extensions, etc.

Fluctuations in Mollusk Populations after a Red Tide in the Estero de Punta Banda, Lower California, Mexico

by

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(Plate 4)

In an earlier issue of this journal it was reported (Stohler, 1959) that during the Red Tide of 1958 in the Estero de Punta Banda in Baja California, Mexico, a collection of mollusks was made. It was noted at that time that a great number of the individuals observed were dead, some of them relatively recently, while others had attained a more advanced state of decomposition. On a map accompanying that report (map C on Plate 6, loc. cit.) two areas were distinguished and designated I (inner portion) and O (outer portion) respectively. In that report it did not seem necessary to stress the fact that the inner portion was separated from the outer one by a relatively massive sand bar which seems to be covered by a thin layer of water only during very high tides. Nor did it seem important at that time to speculate on the possible significance of this sand bar in its effect upon the changing of the water in the inner portion. However, in the light of the present progress report it appears now desirable to consider this possible effect. It seems obvious that the inner portion would be isolated from the open ocean by the bar for a considerable portion of the time, at least during that part of the year when the high and low

waters differ but little from each other. The conclusion that the inner portion would be subject to conditions which might be called "stagnant" seems inevitable. This "stagnant" condition might be assumed to cause more thorough contamination of the invertebrates living in the inner portion if such contaminating conditions do occur and somehow enter this area — as they did, in fact, enter in 1958. This conclusion seems to receive support from the observations made on June 15, 1958: death and decomposition were more pronounced in the inner portion. It was here where the *Sipunculus nudus* were observed as reported (Stohler, loc. cit., p. 33).

Bearing this fact in mind, it appears permissible to project that the total population in the inner portion would suffer more severely than that in the outer portion; additionally it seems logical to assume that a recovery to normal conditions would progress more rapidly in the outer portion than in the inner one.

During the month of July, 1959, it was possible for me to revisit the Estero de Punta Banda, again in company of Mr. and Mrs. Alan H. Wolfson of San Diego. Because of the importance attaching to thorough collect-

ing, two days were devoted to it, namely July 18 and 19. On the first day, both portions, the inner and the outer, were worked over. It was evident, however, that the inner portion was relatively poor and therefore the second day was spent in the outer portion only. On January 11, 1960 I had a third opportunity to collect in the Estero.

In July, 1959, the mollusk population appeared normal and healthy except that the impression was strong that none of the individuals was as large as had been observed the previous year. Moreover, it seemed that the bubble shells, *Vesica gouldiana* (Pilsbry, 1895) were in the midst of their breeding season. The bright orange egg strings were literally everywhere. Equally striking was the abundance of *Pyramidella mexicana* Dall & Bartsch, 1909. This species seemed to congregate in shallow depressions of the sand where it was possible to pick them up a dozen or more at a time.

The picture in January, 1960, however, was totally different. Most striking was the complete absence of some of the forms that had been abundant to very common on the previous occasions. On the other hand, some species were collected that had not been met in the previous two years.

Table 1 lists all species encountered arranged strictly alphabetically. The identifications of some of these species have been verified by Drs. Leo G. Hertlein and Myra Keen, and by Mr. Allyn G. Smith, all three of whom I wish to thank for their courteous cooperation.

The table is divided into three main sections corresponding to the three calendar years during which collections were made. Each main section in turn is subdivided into I (inner section) and O (outer section). The plus sign in any column indicates that the species was collected or observed, while the negative sign indicates that the species was not seen. As any experienced field collector knows, the rarer species are not always encountered even though they are present. Thus, their absence in any of the columns is not considered significant on the basis of what other observations have been made. In this category — species observed in 1958 or 1959 but not in 1960 — belong those marked with a superior 1 preceding the name. (It seems desirable to mention here that through

an unfortunate error in cutting the stencils, the name of *Acteocina* was garbled in the previous report; in proof reading the error was caught but the correction was overlooked; the species is, of course, *Acteocina culcitella intermedia* Willett, 1928, not *A. californica* Willett, a name which, fortunately, does not exist.)

Perhaps the only species which might not be expected in this first group is *Astraea undosa* (Wood, 1828). This species is encountered in great numbers only a few miles to the north in what appear to be identical conditions, namely in the Flood Control Channel in San Diego. Yet in the Estero only one single specimen was found; it was, however, a very juvenile shell, measuring but 6.1 mm. in its greatest diameter. It may be said that *A. undosa* is not to be considered a normal component of the mollusk population in the Estero.

More startling, perhaps, than any other single observation, might be the complete absence in 1960 of the two species marked with a superior 7, *Cerithidea californica* (Haldeman, 1840) and *Melampus olivaceus* Carpenter, 1857. Both species were very common among the sedges along the edge of the Estero in 1958 and 1959. In fact, it was reported (Stohler, loc. cit., pp. 33 and 35) that they were not affected by the Red Tide in 1958. However, the disappearance of these two species together with the fiddler crab, which was equally common before, is due entirely to human influence. Sometime between July, 1959, and January, 1960, large masses of earth and mud had been dumped on this specific area, burying the snails and crabs under several feet of material.

Six of the species encountered only once are marked with a superior 5. All were obtained in 1960, and five of them are pelecypods. In the light of a study being conducted on the variability of the species of *Chione*, the species *Ch. cortezi* (Carpenter, 1864) and *Ch. fluctifraga* (Sowerby, 1853) deserve special mention here. It is interesting that four different species of this genus were collected in the same ecological niche. It is even more interesting to me that it was not until 1960 that all four were obtained.

Another group of species is of interest also; it is marked with a superior 2 in table 1. This group could be subdivided justifiably

Table 1: Species of Mollusks from Estero de Punta Banda, B. C., Mexico

	1958 June 15		1959 July 18 19			1960 January 11	
	I	O	I	O	O	I	O
¹ <i>Acmaea conus</i> GRANT, 1945	—	+	—	—	—	—	—
² <i>Acmaea depicta</i> (HINDS, 1842)	—	+	—	+	+	—	—
¹ <i>Acteocina culcitella intermedia</i> WILLETT, 1928	+	—	—	—	—	—	—
¹ <i>Astraea undosa</i> (WOOD, 1828)	—	+	—	—	—	—	—
¹ <i>Balcis micans</i> (CARPENTER, 1863)	—	—	—	+	—	—	—
⁷ <i>Cerithidea californica</i> (HALDEMAN, 1840)	+	—	+	—	—	—	—
⁶ <i>Chione californiensis</i> (BRODERIP, 1835)	+	+	+	+	+	+	+
⁶ <i>Chione cortezi</i> (CARPENTER, 1864)	—	—	—	—	—	+	—
⁵ <i>Chione fluctifraga</i> (SOWERBY, 1853)	—	—	—	—	—	+	—
³ <i>Chione undatella</i> (SOWERBY, 1835)	+	+	—	—	—	+	+
² <i>Conus californicus</i> HINDS, 1844	—	+	—	+	—	—	—
⁶ <i>Crepidula onyx</i> SOWERBY, 1824	—	+	—	—	+	—	+
⁴ <i>Crepidatella lingulata</i> (GOULD, 1846)	—	—	—	—	+	—	+
¹ <i>Cumingia californica</i> CONRAD, 1837	+	—	—	—	—	—	—
⁶ <i>Donax californica</i> CONRAD, 1837	—	+	+	+	+	—	+
⁶ <i>Donax gouldii</i> DALL, 1921	—	+	—	+	—	—	+
¹ <i>Epitonium cf. cooperi</i> STRONG, 1930	—	—	—	+	—	—	—
¹ <i>Eudaphnella spec.</i>	—	—	—	+	—	—	—
¹ <i>Haminoea vesicula</i> (GOULD, 1856)	—	+	—	—	—	—	—
⁶ <i>Jaton festivus</i> (HINDS, 1844)	—	—	—	—	—	—	+
⁶ <i>Laevicardium substriatum</i> (CONRAD, 1837)	—	—	+	+	+	+	—
¹ <i>Littorina planaxis</i> PHILIPPI, 1847	—	—	—	—	+	—	—
⁶ <i>Lyonsia californica</i> CONRAD, 1837	—	—	—	—	—	—	+
¹ <i>Macoma nasuta</i> (CONRAD, 1837)	—	—	—	—	+	—	—
⁶ <i>Mactra californica</i> CONRAD, 1837)	—	—	—	—	—	—	+
⁷ <i>Melampus olivaceus</i> CARPENTER, 1857	+	—	+	—	—	—	—
⁶ <i>Mitrella cf. c. carinata</i> (HINDS, 1844)	—	+	—	+	+	—	+
³ <i>Modiolus rectus</i> (CONRAD, 1837)	—	+	—	—	—	—	+
⁵ <i>Mytilus edulis</i> LINNAEUS, 1758	—	—	—	—	—	—	+
² <i>Nassarius tegulus</i> (REEVE, 1853)	+	+	+	+	+	—	—
⁶ <i>Olivella baetica</i> MARRAT, in SOWERBY, 1871	—	+	—	+	+	—	+
⁶ <i>Olivella biplicata</i> (SOWERBY, 1825)	—	+	—	+	+	+	+
² <i>Pecten l. latiauratus</i> CONRAD, 1837	—	+	—	—	+	—	—
⁶ <i>Polinices reclusiana</i> (DESHAYES, 1839)	+	+	+	+	+	+	+
¹ <i>Protothaca staminea</i> (CONRAD, 1837)	+	—	—	—	—	—	—
² <i>Pyramidella mexicana</i> DALL & BARTSCH, 1909	+	+	+	+	+	—	—
¹ <i>Tagelus californianus</i> (CONRAD, 1837)	+	—	—	—	—	—	—
¹ <i>Tellina arenica</i> HERTLEIN & STRONG, 1949	—	—	+	—	+	—	—
² <i>Tricolia compta</i> (GOULD, 1855)	—	+	—	+	+	—	—
⁶ <i>Vesica gouldiana</i> (PILSBRY, 1895)	+	+	+	+	+	+	+

observed: ¹) in 1958 or 1959, but not in 1960; ²) in 1958 and 1959; ³) in 1958 and 1960; ⁴) in 1959 and 1960; ⁵) in 1960 only; ⁶) in all three years; ⁷) covered over by several feet of mud and earth

into two subgroups. Into the first subgroup would belong Acmaea depicta (Hinds, 1842), Pecten l. latiauratus Conrad, 1837, and Tricolia compta (Gould, 1855). These three species were found in 1958 and 1959, associated with the eel grass Phyllospadix torreyi Watson. In January, 1960, the eel grass was absent and no trace of this plant could be observed. It may be argued that the absence in 1960 of the three species of mollusks was a direct consequence of the disappearance of Phyllospadix. On the other hand, the second subgroup consisting of Conus californicus Hinds, Nassarius tegulus (Reeve, 1853), and Pyramidella mexicana Dall & Bartsch, 1909, not being dependent upon this "host" plant, could not be assumed to have been affected in the same way and yet these three species also were not observed in 1960.

In Table 2 are given figures obtained by measuring the different lots of Pyramidella mexicana collected. The impression previously mentioned, that the specimens in 1959 were not as large as those observed the year before is confirmed by the actual measurement of every specimen collected. The table also shows that the Pyramidella population in the outer portion had a more normal appearance in 1959 as to numbers of individuals. The comparison of the two sets of figures, however, makes the total disappearance of this species even more striking. If the samples of both areas are pooled for the respective years, the following mean sizes are obtained: in 1958: 16.3 mm.

in 1959: 13.3 mm.

This difference of almost 20% is even more surprising if one considers that the collecting date was one month later in the year in 1959 than in 1958; this fact might lead one to assume that on the basis of an annual cycle the population would be older in July than it is in June and therefore the average size of the shells should be larger in the later month. No logical explanation for the reversed condition comes to mind and this must remain, for the time being, another riddle to be solved in the future.

Yet, at the same time, the decrease in size cannot be attributed, I believe, to an after-effect of the Red Tide nor could it have been interpreted as foreshadowing the complete disappearance of the species.

Breeding cycles cannot be adduced, I believe, for an explanation either, since very

small individuals were obtained in 1959. This fact can only be interpreted, it seems, to mean that the generations overlap at least to some extent, if it does not indicate that the individuals live for more than one whole year. Of course, we encounter a great handicap here, since we know very little about life spans of mollusks in general.

Only two species were found in 1958 and in 1960, but not encountered in 1959. These two, Chione undatella (Sowerby, 1835) and Modiolus rectus (Conrad, 1837), are marked with a superior 3. At the present status of this continuing study nothing more can be said about these forms than to note the fact. The same applies to the single species, Crepidatella lingulata (Gould, 1846), found in 1959 and 1960; it is marked with a superior 4 in our table.

Table 2: Pyramidella mexicana

(Measurements in millimeters)

		greatest height	mean height	greatest diameter	number of individuals
I	1958 la	19.3	17.1	6.4	23
	sm	9.0		3.7	
	1959 la	20.5	14.4	6.7	44
	sm	9.8		4.5	
	1960 la	—	—	—	—
	sm	—		—	
O	1958 la	21.3	16.0	7.5	53
	sm	9.8		3.6	
	1959 la	21.9	13.2	7.1	358
	sm	5.9		2.8	
	1960 la	—	—	—	—
	sm	—		—	

The last group of species includes the dominant forms, which were obtained on each of the three occasions. They are marked in the table with a superior 6. While we will single out two species of this group for a more detailed scrutiny, it is understood that fundamentally the same facts apply to the other eight species so designated.

Chione californiensis (Broderip, 1835)

Chione, to be considered first, is easily collected, even when it is healthy. For this reason it seems to be a favored item for the food collectors. In spite of the ease of collecting, only relatively small numbers were

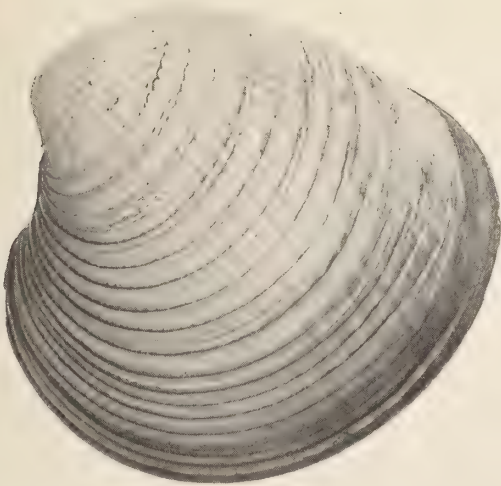


Figure 1

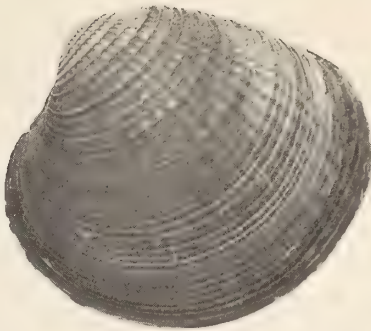


Figure 2

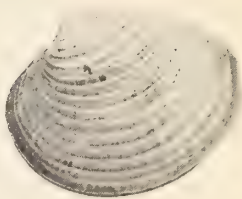


Figure 3

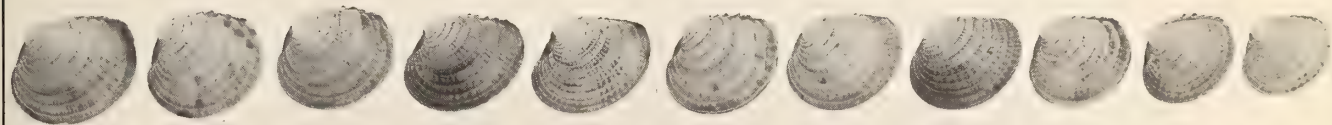
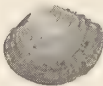
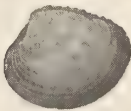


Figure 4

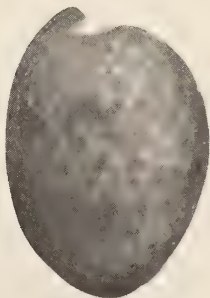


Figure 5



Figure 6



Figure 7

All Figures Natural Size - See Text for Explanation

picked up. The reasons for this are that in 1958 it was not considered desirable to accumulate a lot of dead specimens; in the following two years there were not many specimens present. In Table 3 are given measurements from each lot collected. Although again the largest and smallest individual was recorded, it was not deemed worthwhile to compute averages, because of the small lots involved. This table reveals that the very largest shell was obtained in 1958 in the outer portion, while the smallest of all was obtained in the inner portion the same year. In our Plate 4 the Figures 1, 2, and 3 show the largest and the smallest specimens collected in the outer portion in the three years, 1958, 1959, and 1960, respectively. The measurements of the shells from the inner portion, on the other hand, show a marked decrease in 1959 (all specimens obtained on that occasion are shown in Figure 4) and a very strong recovery by January, 1960.

Table 3: *Chione californiensis*
(Measurements in millimeters)

		greatest height	greatest diameter	number of individuals
I	1958 largest	56.1	58.7	12
	1958 smallest	7.7	9.2	
	1959 largest	14.6	18.0	11
	1959 smallest	10.8	13.1	
	1960 largest	52.3	56.7	20
	1960 smallest	20.1	23.9	
O	1958 largest	67.2	69.4	17
	1958 smallest	14.3	17.3	
	1959 largest	44.5	50.2	10
	1959 smallest	11.1	13.3	
	1960 largest	25.9	32.1	11
	1960 smallest	11.5	13.9	

Based on *Chione californiensis* alone it is very tempting to conclude that the adult and, possibly even senile, individuals were destroyed in 1958 but that the juveniles somehow escaped total destruction. This, at least, seems the picture conveyed in the inner portion. Certainly, the eleven individuals shown in Figure 4 can be said to be members of the same "brood". But the outer portion seems to offer strong evidence against this assumption. Each year the

largest specimen obtained there was approximately one-third smaller than the corresponding specimen of the previous year. Surely, no delayed effect can be ascribed to the Red Tide.

Table 4: *Vesica gouldiana*
(Measurements in millimeters)

		greatest height	greatest diameter	number of individuals
I	1958 largest	none collected		
	1958 smallest	see text		
	1959 largest	none collected		
	1959 smallest	see text		
	1960 largest	40.1	28.2	22
	1960 smallest	12.6	8.7	
O	1958 largest	39.4	29.1	3
	1958 smallest	34.9	24.6	
	1959 largest	35.5	25.8	8
	1959 smallest	12.3	8.4	
	1960 largest	15.0	10.0	5
	1960 smallest	7.2	4.9	

Vesica gouldiana (Pilsbry, 1895)

A similarly confusing picture is presented by *Vesica gouldiana* (Pilsbry, 1895) (see Table 4). No attempt was made to obtain large series of this species; only representative sizes were selected in 1958 and 1959. In the inner portion, in fact, not a single individual was collected in the two years. In 1958 this was omitted because the vast majority of bubble shells were already decaying and in 1959 the population appeared normal and engaged in egg laying. However, specimens were collected in the inner portion in 1960, and these fall well within the range of a normal population.

In the outer portion, on the other hand, the same more or less gradual decline in size is observed as has been noted for *Chione*. It was noted in 1959 that the *Vesica* were spawning here, too, just as those in the inner portion. But in 1960 the absence of large, mature individuals in the outer portion was noteworthy. Figures 5 and 6 of Plate 4 show the largest live collected shell obtained in 1958 and 1959, respectively, both from the outer portion; in Figure 7 are shown all individuals collected in the same place in 1960. It could be added that there

were so many of these small, young individuals that an estimate in the thousands per acre would not be an exaggeration.

It must be admitted that the temptation is great to interpret the fluctuations in the mollusk populations in the Estero de Punta Banda as a direct consequence of the poisonous or otherwise detrimental effect of the Red Tide of 1958. Yet a careful consideration of all the facts presented as well as those merely alluded to (I am referring here to the other species of Group 6 not discussed in detail, as unnecessary duplication was avoided) seems to point inevitably to other factors as responsible for the phenomenon. The outer portion with the much freer flow of water during the changing of the tides should have recovered completely, or at least almost so, by 1960. In the inner portion, where the tidal changes seem to be less complete, the deleterious effect of the Red Tide might have made itself felt for a much longer time and furthermore, the recovery rate might have been considerably slower. Yet just the reverse seems to be the case. Seasonal fluctua-

tions in environmental conditions can almost certainly be ruled out as responsible for the differences between the inner and outer portion. Reproductive cycles cannot be held responsible in the case of Chione since the presence of large and small individuals (see again Figures 1, 2, and 3, Plate 4) tends to support the view that this species has a more or less continuous breeding season. At this time, it seems only safe to say that these fluctuations have been observed but that their connection with the Red Tide is not demonstrable beyond the fact that they occurred after the Red Tide and, further, that the real factors responsible might be uncovered only through a continued study — which I hope may be carried on.

LITERATURE CITED

Stohler, R.

1958. The Red Tide of 1958 at Ensenada, Baja California, Mexico. *The Veliger*, 2(2): 32-35, pl. 6, 7.

The Riddle of the Bivalved Gastropod

by

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Early last November I was one of several guests of the Belvedere Scientific Fund on a trip to the La Paz area, Gulf of California. At a cove near the northwest corner of Espiritu Santo Island we found some unusually rich beach drift. Sorting this later, I found a single valve of what seemed to be the erycinid pelecypod, Scintilla? chloris Dall, but I noted one distinctive feature, a spiral nucleus that recalled figures of an Australian bivalve, Edenttellina. Shortly thereafter came a paper by two Japanese workers, Kawaguti and Baba (1959), announcing discovery of an opisthobranch gastropod with a two-valved shell. Their figures could almost have been of the little shell I had. This was something to stir one's pulse! The implications started a flurry of letters between interested persons in four countries, as we compared notes and brought new evidence to light, some of which has by now been published (see References).

Dr. Siro Kawaguti, of Okayama, Japan, collected the first specimens of Tamanovalva limax — as it was to be called — in August, 1959. Collaborating with Japan's foremost specialist on opisthobranchs, Dr. Kikutaro Baba, he published a brief account with description of the form as a new genus, new species. The soft parts were definitely those of a gastropod. The salient characteristics of the bivalved shell were the spiral nucleus in one valve, greenish coloration, and a single subcentral muscle scar. Kawaguti and Baba mentioned the Australian form Edenttellina, but, assuming it to be a pelecypod, made no direct comparisons. In two subsequent papers Kawaguti has given additional information on the habits and the life history of Tamanovalva, which he has been able to culture successfully. He has, in fact, recently informed me, by letter, that he now has in his aquaria "children and grandchildren" of the original material.

Two British colleagues, Drs. L. R. Cox and W. J. Rees, realizing the importance of the Japanese discovery and fearing that the journals in which it was reported would be of limited circulation, published an essay-review in the *British Nature* (Cox and Rees, 1960). They pointed out the strong resemblance of Tamanovalva to the figures of the Australian Edenttellina and urged a search for living specimens of the latter, which as yet were unknown. A few days before their paper appeared in print in England, an Australian collector, Mr. Robert Burn (who had already been alerted by correspondence as to the probable habitat in which to search), succeeded in finding Edenttellina alive. As predicted, it turned out to be an opisthobranch gastropod (Burn, 1960). Not only does Edenttellina inhabit exactly the same niche as Tamanovalva, on the roots and tips of the green alga Caulerpa in tide-pools at low tide level, but it has all of the other distinctive features. Tamanovalva thus becomes a synonym of the earlier Edenttellina Gatliff and Gabriel, 1911. However, the picture has further complications.

Hedley (1920), an Australian malacologist, had pointed out that some of the forms from the Eocene in the Paris Basin bear a close resemblance to the Australian Edenttellina. He had, in fact, employed the name Ludovicia for the Australian shells before the name Edenttellina had been proposed. Ludovicia had been validated by Cossmann in 1888 from a Deshayes manuscript but was not used widely because many workers thought it to be a homonym. Cossmann also proposed the name Anomalomya in 1888 for a very similar shell. Earlier than either of these is Berthelinia Crosse, 1875. Published figures of Berthelinia show well the spiral nucleus and the single muscle scar. I have had the good fortune to see some specimens in the University of California collection and can testify that these shells, from Middle and Upper Eocene horizons in France, are distinguishable from the Recent Japanese form only in minor details of outline. Therefore, it seems fairly conclusive that Tamanovalva is a synonym not only of Edenttellina but also of Berthelinia. Although all of these four earlier-named genera have been allocated to various families in the Pelecypoda, one notes with interest that Crosse, when describing Berthelinia, thought it might be a gastropod, near Capu-

lus. Later, Crosse and Fischer (1887), finding opposite valves, reassigned the genus to Pelecypoda, in the family Prasinidae (now known as Juliidae). Cossmann, too, was aware of a gastropod resemblance in Ludovicia, which he placed in Galeommidae; he said he would have called it a gastropod if he had not seen the two valves. Hedley remarked on Edenttellina that he would otherwise have considered it the internal shell of an opisthobranch. How near he was to the truth! The genus is, however, classified in Juliidae by modern authors. Cossmann placed Anomalomya here, too, under the earlier family name Prasinidae.

The question now arises, what points of resemblance are there between the Berthelinia complex and the rightful members of Juliidae? The family is a small one, both in size of shell and in number of taxa, with — otherwise — only one genus, Julia Gould, 1862 (synonym, Prasina Deshayes, 1863) and nine named species. The geologic range is from the Miocene (Europe, the Caribbean, and the East Indies) to the Recent. Beets (1944), in a review of Julia, shows that it now ranges, in the tropics, from East Africa to Polynesia. A West American species, J. equatorialis, was described by Pilsbry and Olsson in 1944, and Howard (1951) suggested that the type species, J. exquisita Gould, might range from Hawaii to West Mexico. In outline the shell is more heart-shaped than that of Berthelinia. The hinge in one valve has a socket, in the other a large, blunt tooth. Most shells are greenish in color. In some species a small spiral nucleus has been noted on young specimens. The muscle scar is central, but it is not a single circular scar. Rather, it is composed of two parts that are hourglass-shaped in some specimens, in others completely divided into two parts, one above the other. No living specimens of Julia have been reported as yet, so that the soft parts are unknown. However, it seems to me that there is a very good chance they will prove to be similar to those of Berthelinia. My conviction is strengthened by Mr. Burn's discovery — simultaneously with the living Edenttellina — of a second bivalved opisthobranch, which he will soon describe as a new genus, having a muscle scar pattern different from that of Berthelinia. This suggests to me considerable plasticity in the group; hence, I feel the more certain that when Julia is found living,

it will prove to be a gastropod. If so, we shall have the novel opportunity of moving not just a genus but a whole family from Pelecypoda to Gastropoda.

To return to the single specimen that came to light in the Espiritu Santo Island drift: It has the greenish color, the form, the spiral nucleus, and the muscle scar of Tamanovalva -- i. e., Berthelinia. One cannot, of course, completely rule out my first identification of Scintilla? chloris until specimens are actually compared with Dall's type, but some notes given me by Dr. Woodring, who has re-examined the type material, increase the likelihood that the new find represents an unnamed species of Berthelinia. Naturally, one is eager to return to Espiritu Santo and make a determined search in the tide-pools for the living animals. Prospects for a double reward are good, for in the sample of beach drift that yielded the one valve of Berthelinia there were three valves of a Julia. Beet's distribution map shows that the range of Julia can overlap the range of Berthelinia at only a few places. The La Paz area is therefore strategically situated. All evidence in the literature suggests that both genera occupy much the same habitat -- green algae just at or just below the low-tide level. Here, then, is an opportunity to whet any collector's enthusiasm. Finding the actual animals, however, will not be an easy task, for the shells are only about 3 mm. in length, and the tiny green animals are said to be extremely hard to see on their chosen forage plant, Caulerpa.

ACKNOWLEDGMENTS

I wish to express my appreciation for the opportunity afforded me by the Belvedere Scientific Fund. A word of thanks is due also the members of the shell-collecting party, especially to Mr. Allyn G. Smith, who sacked up the drift material that yielded the valves of Berthelinia and Julia. Dr. Siro Kawaguti has supplied not only reprints of his papers but a color slide of Tamanovalva, and Dr. Kikutaro Baba has sent both literature and two specimens in alcohol. Mr. Edwin Allison made available for study the fossil specimens of Berthelinia in the University of California collection. To the several correspondents who each contributed some piece of information I am also grateful -- Mr. Robert Burn, Mr. B. C. Cotton, Dr.

L. R. Cox, Dr. Nell Ludbrook, Dr. Hope MacPherson, and Dr. W. P. Woodring.

LITERATURE CITED

- Beets, C.
1944. Die Lamellibranchiaten-Gattung Julia Gould. Geologie en Mijnbouw, n.s., Jahrg. 6, no. 3-4, pp. 28-31 (Mar.-Apr.).
- Burn, Robert
1960. A bivalve gastropod. Nature, vol. 186, no. 4719, p. 179 (Apr. 9).
- Cossmann, M.
1888. Catalogue illustré des coquilles fossiles de l'Eocene des environs de Paris. Ann. Soc. Roy. Malac. de Belgique, vol. 22 (for 1887), pp. 45, 169.
- Cox, L. R. and W. J. Rees
1960. A bivalve gastropod. Nature, vol. 185, no. 4715, pp. 749-751 (March 12).
- Crosse, H.
1875. Description du nouveau genre Berthelinia. Jour. de Conchyl., vol. 23, pp. 79-81.
- Crosse, H. and P. Fischer
1887. Observations sur le genre Berthelinia. Ibid., vol. 35, pp. 305-311, 1 fig.
- Hedley, Charles
1920. Concerning Edentellina. Proc. Malac. Soc. London, vol. 14, pp. 74-76, 8 figs.
- Howard, A. D.
1951. The family Juliidae. Nautilus, vol. 64, no. 3, pp. 84-87, pl. 6 (Jan.).
- Kawaguti, S. and K. Baba
1959. A preliminary note on a two-valved sacoglossan gastropod, Tamanovalva limax, n. gen., n. sp., from Tamano, Japan. Biological Jour. Okayama Univ., vol. 5, nos. 3-4, pp. 177-184 (Sept. 30).
- Kawaguti, S. and T. Yamasu
1959. A bivalved sacoglossan gastropod, Tamanovalva limax. Zoological Magazine (Dobutsugaku Zasshi), vol. 68, no. 12, pp. 442-446, 1 fig. (Dec. 15). In Japanese, with English summary.
- Kawaguti, S.
1959. Formation of the bivalve shell in a gastropod, Tamanovalva limax. Proc. Japan Academy, vol. 35, no. 10, pp. 607-611, 5 figs.
- Keen, A. Myra
1960. A bivalve gastropod. Nature, vol. 186, no. 4722, pp. 406-407 (Apr. 30).

Notes & News

Range Extensions of Two
Panamic Gastropods

by

GALE G. SPHON, JR.

Conchological Club of Southern California, Los Angeles

During a collecting trip to Baja California, Mexico, from December 26, 1959, to January 4, 1960, range extensions of two gastropods previously known only from Central America were discovered.

MITRA ERYTHROGRAMMA TOMLIN, 1931

Mitra erythrogramma Tomlin is reported by Keen (1958) as having the range "Nicaragua to Colombia". On December 31, 1959, a specimen was collected at Bahia San Luis Gonzaga, Baja California, Mexico. It was collected by lantern light at night on an extremely low tide. It was crawling on the sand between two sand bars in a channel of moderately swiftly draining water about two inches deep.

A tentative field identification was made and later was confirmed by Dr. Myra Keen at Stanford University. This single specimen has also been compared with specimens of Mitra erythrogramma in several private collections and with material in the Los Angeles County Museum.

The previous range, when rounded off to the nearest degree of latitude, would be from 7°N. to 13°N. (The southern boundary of Colombia and the northern boundary of Nicaragua.)

Bahia San Luis Gonzaga is located at approximately 30°N. latitude which makes this an extension of approximately 17° and about 900 miles northward of the previously reported range.

CRASSISPIRA GRANDIMACULATA
(C. B. ADAMS, 1852)

A single specimen of this species was collected at low tide under a rock at Puertecitos, Baja California, Mexico, on December 28, 1959. A field determination of Crassispira sp. was made and later the specimen was sent to Dr. Myra Keen, who made the specific determination.

The previous range is given by Keen (loc. cit.) as "Nicaragua to Panama". If one takes

the southern boundary of Panama and the northern boundary of Nicaragua and rounds them off to the nearest degree of latitude, the range would be from 9°N. to 13°N. latitude. When the range is extended to Puertecitos, which is located approximately 30°N., it is an extension of 17° or about 900 miles northward.

The two specimens discussed are in the author's personal collection.

Generous assistance from friends and institutions and especially from Dr. Myra Keen is gratefully acknowledged.

LITERATURE CITED

- Keen, A. Myra
1958. Sea shells of tropical West America. Stanford Univ. Press, XI, 624 p., illus.

Research Request

This is a call upon the kind assistance of all readers of *The Veliger* to place collections of egg masses or any observations or notes on reproductive or breeding habits of Californian Marine Prosobranchs at my disposal for working up a monograph on prosobranch reproduction from the whole world.

I have collected material for this purpose for over 13 years and I have studied personally the egg masses and development of more than 350 species of Prosobranchs in East Greenland, Scandinavia, the Canary Islands, West Africa, Florida, California, and the Persian Gulf; comprehensive collections from the Antarctic, Australia, Chile, and several other places were given me on loan.

Still several gaps persist, which should be filled up before completing the manuscript. All material sent me will be treated carefully and returned after examination; full credit will be given to all collectors or observers when the monograph is published. Any expenses in sending material from California to Elsinore will be gladly refunded from this laboratory.

sig. Prof. Gunnar Thorson,
Marine Biological
Laboratory
Elsinore (Helsingør),
Denmark

Paul Bartsch

(1871-1960)

Word has just been received of the passing in Lorton, Virginia, of Dr. Paul Bartsch, former Curator of Mollusks at the United States National Museum, at the age of 89. Dr. Bartsch's contributions to malacology have been extensive, covering more than a half-century. His close collaboration with Dr. William Healey Dall, his predecessor at the National Museum, has made the scientific signature of "Dall & Bartsch" an immortal combination in the literature on mollusks, occupying a significant section of a twentieth century conchological library.

Paul Bartsch was an all-around conchologist and malacologist who, on his own account, made large and important contributions to the general knowledge of mollusks, especially their classification, distribution, and taxonomy. Other journals will no doubt do full justice to his years of research work and accomplishments. Suffice it to say here, however, that west coast conchologists and malacologists will long be indebted to him for his painstaking work on a number of difficult genera of minute west American marine shells. His monographs on the Vitrinellidae (1907), *Macromphalina* (1907), *Triphoris* (1907), *Alaba* (1910), *Alabina* (1911), *Eumeta* (1911), *Diastoma* (1911), *Cerithiopsis* (1911), *Bittium* (1911), *Aclis* (1911), *Amphithalamus* (1911), *Nodulus* (1911), *Alvania* (1911), *Cingula* (1912), *Pyramidellidae* (1912), *Rissoina* (1915), *Melanella* (= *Balcis*) (1917), and *Barleeia* (1920) still stand as prime references for identification.

Dr. Bartsch was one of the organizers, a past president (1933), and an honorary life president of the American Malacological Union.

-- A. G. Smith

Books, Periodicals, Pamphlets

The Great Barrier Reef and Adjacent Isles by Keith Gillett, photography and related text, and Frank McNeill, Curator at the Australian Museum, Sydney, general

text. Coral Press, Paddington, Sydney, Australia, 1959.

This is a beautifully bound book illustrated with 27 color plates, 134 black-and-white photographic illustrations, 4 charts, and 3 figures.

Pages 62 to 94, incl., deal exclusively with mollusks. The illustrations are superb, and the text descriptions of the mollusks are well done. It is to be regretted that some other Australian authors did not employ the remarkable photographic skill of Mr. Gillett.

Every shell may be immediately recognized in this work. There is no doubt but that others as well as this writer will be pleased to see some fine figures showing all characters of species heretofore assigned with doubt due to poor illustrations.

The only criticism may be that in the opinion of some of us, the Australian authors are disposed to overclassify. The generic names used for the species of *Conidae*, *Cypraeidae*, etc., are those many of us think would serve as well as subgenera or sections.

-- John Q. Burch

Universal Shells by Maxwell Smith. World-Wide Sea Shells was published in 1940. The author states that there has been an insistent demand for a more comprehensive work containing not only illustrations but also detailed descriptions of the various families of mollusks and their principal genera.

The new book will contain nearly 300 pages and about 2000 separate illustrations. The Cephalopods, Gastropods, Pteropods, and the Amphineura are included in the first volume. This is now in press and should be ready early in 1960. The second part will appear in 1961, or earlier. The latter will contain the Pelecypoda together with land and fresh-water shells.

Universal shells will contain some color plates but chiefly line drawings which are most satisfactory for identification purposes. There will also be an essay by Dr. Joshua L. Bailey, introductory matter, maps and figures from obscure and out-of-print publications. The first volume is priced at \$7.50

-- John Q. Burch

THE VELIGER is open to original papers pertaining to any problem concerned with mollusks from the Pacific Region.

This is meant to make facilities available for publication of articles from a wide field of endeavor. Papers dealing with ecological, morphological, anatomical, physiological, distributional, taxonomic, etc. aspects of marine, fresh water or terrestrial mollusks from any region bordering on or situated within the Pacific Ocean, will be considered. Even topics only indirectly concerned with mollusks may be acceptable.

It is the editorial policy to preserve the individualistic writing style of the author; therefore any editorial changes in a manuscript will be submitted to the author for his approval, before going to press.

Short articles containing descriptions of new species or lesser taxa will be given preferential treatment in the speed of publication provided that arrangements have been made by the author for depositing the holotype with a recognized public Museum. Museum numbers of the type specimens must be included in the manuscript. Type localities must be defined as accurately as possible, with geographical longitudes and latitudes added.

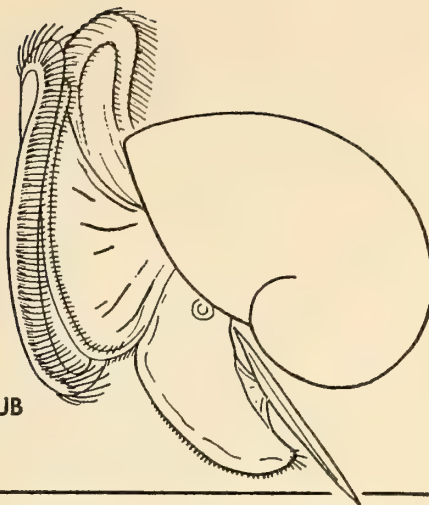
Short original papers, not exceeding 500 words, will be published in the column "NOTES & NEWS"; in this column will also appear notices of meetings of the American Malacological Union, as well as news items which are deemed of interest to our subscribers in general. Articles on "METHODS & TECHNIQUES" will be considered for publication in another column, provided that the information is complete and techniques and methods are capable of duplication by anyone carefully following the description given. Such articles should be mainly original and deal with collecting, preparing, maintaining, studying, photographing, etc., of mollusks or other invertebrates. A third column, entitled "INFORMATION DESK," will contain articles dealing with any problem pertaining to collecting, identifying, etc., in short, problems encountered by our readers. In contrast to other contributions, articles in this column do not necessarily contain new and original materials. Questions to the editor, which can be answered in this column, are invited. The column "BOOKS, PERIODICALS, PAMPHLETS" will attempt to bring reviews of new publications to the attention of our readers. Also, new timely articles may be listed by title only, if this is deemed expedient.

Manuscripts should be typed in final form on a high grade white paper, 8½" by 11", double spaced and accompanied by a carbon copy.

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Notes on the Taxonomy of the Pelecypod Genus *Corbula* BRUGUIÈRE, 1798

by

JOHN Q. BURCH

Conchological Club of Southern California, Los Angeles 7, California

With no thought of adding to the scholarly diagnoses of Doctors Julia Gardner, Harold E. Vokes, and H. A. Pilsbry, it would seem that a few words on this controversial matter may be in order. There is nothing more disturbing than to have our most respected authors using different names for the same genus or species. We receive specimens as well as publications about evenly divided between those which use *Aloidis* Megerle von Mühlfeld, 1811, and those which use *Corbula* Bruguière, 1798. A recent publication of the Malacological Society of the Netherlands contains a paper in which the author accepts *Aloidis*. Two other current papers prefer *Corbula*.

Briefly stated, the problem is based upon the fact that Bruguière in 1798 published (in the *Encyclopédie Méthodique*) a plate of 18 figures which he headed *Corbula*. He used no trivial names but his species have been identified. Article 25 of the International Code of Zoological Nomenclature states that a valid name of a genus or species must be accompanied by an indication, or a definition, or a description. Winchworth (), followed by others, considered that Article 25 made Bruguière's plate inadmissible.

Pilsbry (1946) stated the case for Bruguière very well as follows: "To hold that a figure is not an 'indication' seems to be a decision of questionable sagacity; but we can remain within the letter of the law by insisting that a figure can be a perfectly satisfactory 'definition'. In fact, it is usually better than a dozen lines of Latin."

The International Commission of Zoological Nomenclature has never published a formal opinion on the Bruguière question although Dr. Harald Rehder of the United States National Museum petitioned them some years ago. However, in the volume that summarizes the Paris meeting, published in the *Bulletin of Zoological Nomenclature*, vol. 4, p. 255 (1950), the statement is made that the Commission agreed to recommend that a legend to a plate, without other explanatory matter, is to be interpreted as constituting an indication. This action on the

part of the Commission was not greeted with favor by Henry Dodge and others. On the other hand, the conclusion has been accepted by some authors including Drs. A. M. Keen and T. Abbott.

Following that recommendation a citation for the genus would be as follows:

Genus *Corbula* Bruguière, 1798. Type species (by subsequent designation Children, 1822) *Corbula nucleus* Lamarck (= *Corbula gibba* Olivi) fide Julia Gardner, *Nautilus*, vol. 40, pp. 41-47, 1926.

Harold E. Vokes, *Bull. Am. Mus. Nat. Hist.*, vol. 86, 1945.

H. A. Pilsbry, *Nautilus*, vol. 60, p. 36, 1946.

Furthermore, there has been a difference of opinion regarding the type species of *Corbula*. Dall and others accepted *Corbula gallica* Lamarck for the type of *Corbula* s.s. *Aloidis* Mühlfeldt, 1811, is monotypic, the type being *Corbula sulcata* Lamarck.

Unfortunately, the acceptance of any of these involves a realignment of the supra-specific groups. The designation of *Corbula gibba* (Olivi) is fortunate because this is a rather common European species.

The Röding fan club must, in this case, swallow their disappointment because Röding's *Corbula* is generally conceded to be in the synonymy of *Asaphis* Modeer, 1793.

Dr. Vokes thought to retain the name as *Corbula* Lamarck, 1799. He arrived at this conclusion by considering Röding (Museum Boltinianum, 1798) "not available", but it is available (Opinion 96 of the International Commission).

The name *Corbula* cannot be retained unless it be dated from the plate of Bruguière (figs. 4 a-d are *Corbula nucleus* Lamarck [= *Corbula gibba* Olivi]) which has priority over Röding. The use of the name *Corbula* Lamarck by Röding, 1798, makes any subsequent use of that name invalid.

Of course, we have some authors who avoid all of these discussions by the simple expedient

of raising all subgenera to generic rank, letting both Corbula and Aloidis go happily where they may.

The hinge of Corbula is simple indeed, with a single large tooth below the umbo in the right valve and a deep resiliary pit behind it. The left valve contains the socket into which the cardinal tooth of the right valve fits. There are no lateral teeth in either valve.

It is a delight to the beginner with hinge characters, the Steinman formula being merely LcO over Rcl.

The family Corbulidae is abundant in many fossil deposits with the result that our paleontologists have described numerous species and subgenera. There are a number of easily recognized supra-specific groups in the Recent fauna as well. A detailed discussion of these would involve one of those countless papers that should perhaps be written, but by no means ever read aloud.

The divergence of opinion regarding the higher groups to contain this family is almost as fantastic, but the nomenclature of the orders and suborders is a minor matter to most of us

and certainly no more amusing than the well known split on the name of the entire class (i.e., Lamellibranchiata - Pelecypoda - Bivalvia).

It is not that Corbula is of unusual interest or importance, but this is a typical example of seemingly countless other problems on which the authorities differ.

LITERATURE CITED

- Bruguière, J. G.
1798. Encyclopédie Méthodique.
Children, J. G.
1822-1824. Lamarck's Genera of Shells translated from the French.
Gardner, Julia
1926. Nautilus, vol. 40, pp. 41-47.
Mühlfeldt, Megerle von
1811. Mag. Ges. Naturf. Freunde, 5, p. 67.
Pilsbry, H. A.
1946. Nautilus, vol. 60, p. 36.
Vokes, Harold E.
1945. Bull. Am. Mus. Nat. Hist., vol. 86, pp. 1-32.

A New Subspecies of *Cypraea saulae* GASKOIN, 1843

by

CRAWFORD N. CATE

Conchological Club of Southern California, Los Angeles 7, California

(Plate 5)

The species Cypraea saulae Gaskoin, 1843, has been represented by three geographical races in the southwestern reaches of the Pacific Ocean: the typical species C. saulae saulae from Manila Bay, C. saulae nugata Iredale, 1935, from Lindeman Island, Queensland, and C. saulae jensostergaardi Ingram, 1939, from Koror Island in the Carolines.

From the obscurity of the Tapul Group in the Sulu Archipelago, in the early days of 1959, a new geographical race of this species appeared. While searching for other species of Cypraea, the Moro collector Gumanti-Kasula came upon two specimens of this new subspecies hidden in

coral and sponge in from two to ten feet of water. In the fourteen months that have elapsed since then, intensive search which was focused particularly upon this shell has turned up only six additional specimens.

It has been established that all of the races of Cypraea saulae are of limited and rare occurrence with only a meager representation of each race ever having been collected. Schilder (1952, p. 158) wrote: "Dautzenberg did not possess this very rare species, the three living races of which need further research for lack of material in present times; we have examined seven shells only, one shell each in the Muse-

um of Cambridge (holotype); Paris; Berlin; École des Mines (Paris); Tomlin Collection (nugata); Vayssière Collection (nugata); and in our own collection (saulae). Outside of Europe, there are very few shells of saulae and nugata preserved, and only one shell of jensostergaardi (Coll. Ingram)."

Representatives of each race differ distinctly, some differences well marked and more easily recognized than others. While the geographical barriers separating these races appear well defined, their morphological differences are less apparent, though clear and constant.

Careful comparisons were made between the various subspecies of this lesser-known Cypraeid, not only from the original descriptions and type figures, but also from a fresh, live-taken toptype of the typical species Cypraea saulae saulae in the author's collection (see plate 5) and from a specimen of C. saulae jensostergaardi in the collection of Mrs. John Q. Burch.

It is interesting to note that these rare shells

of the new subspecies share the same ecology and habitat with the other less-rare species listed here.

- Cypraea boivini Kiener, 1843
C. helvola helvola Linnaeus, 1758
C. hirundo neglecta Sowerby, 1837
C. ziczaz ziczac Linnaeus, 1758
C. microdon microdon Gray, 1828
C. kieneri depriesteri Schilder, 1933
C. bistrinotata mediocris Schilder and Schilder, 1937
C. globulus globulus Linnaeus, 1758
C. cicerula cicerula Linnaeus, 1758
C. staphylaea staphylaea Linnaeus, 1758
C. asellus vespacea Melvill, 1905
C. punctata atomaria Gmelin, 1791
C. felina pauciguttata Schilder, 1938
C. nucleus nucleus Linnaeus, 1758
C. fimbriata marmorata Schröter, 1804
C. fimbriata unifasciata Mighels, 1845
C. teres teres Gmelin, 1781
C. lutea lutea Gronow, 1781
C. onyx onyx Linnaeus, 1758

Table 1: Comparative Measurements of Subspecies of Cypraea saulae

[Measurements in millimeters]

	Length	Width	Height	Location
<u>Cypraea saulae siasiensis</u> CATE, subsp. nov.				
Holotype	25.0	13.5	10.8	B. P. Bishop Museum (No. 212719)
Paratype 1	22.5	12.8	10.0	C. N. Cate Collection
Paratype 2	27.5	14.9	12.2	C. N. Cate Collection
Paratype 3	21.8	11.6	9.7	C. N. Cate Collection
Topotype 1	26.8	14.0	11.0	Manila, Philippine Islands
Topotype 2	24.0	13.0	11.0	Manila, Philippine Islands
Hypotype [subadult]	23.4	13.8	10.0	C. N. Cate Collection
<u>Cypraea saulae saulae</u> GASKOIN, 1843				
Topotype	27.0	15.1	12.4	C. N. Cate Collection
<u>Cypraea saulae nugata</u> IREDALE, 1935				
Holotype	22.0	12.0	10.0	Australian Museum
<u>Cypraea saulae jensostergaardi</u> INGRAM, 1939				
Holotype	17.0	10.0	9.0	W. M. Ingram Collection (No. 1114)
Hypotype	19.9	10.1	9.1	Mrs. John Q. Burch Collection

The distinctly rare C. contaminata contaminata Sowerby, 1832, is also represented by four specimens found in the same area during the same fourteen-month period when the new subspecies was being taken.

Cypraea saulae siasiensis Cate, subsp. nov.
(see plate 5)

Shell light and somewhat fragile; cylindrically ovate, attenuating sharply to a well produced anterior terminal collar; deeply umbilicated posteriorly, the canal curved to the left; right margin strong; lateral shelves appearing right and left at base of anterior terminal collar; posterior terminal strongly margined, reflected to the left. Aperture curved, flexuous, and narrow; teeth fine, strong, short, and numerous, not extending onto the fossula; labial teeth strong, thickened. Terminal ridge oblique; columella bulbous, curving; fossula broad and smooth, suggesting two or three faint teeth anteriorly. Dorsum light dove-gray, ornamented with a single, central, chestnut-brown blotch; faint brownish tint suffused into umbilicus; dove-gray paling perceptibly at margins and on base; teeth white, terminals and interstices deep yellow-orange, margins speckled with small chestnut spots. Very few minute pale brown flecks are scattered irregularly over the dorsum. There is no mantle line.

Key to the subspecies of Cypraea saulae

- | | |
|---------------------------------|------------------------------|
| 1. Two or more dorsal blotches | 2 |
| Not more than one dorsal blotch | <u>C. s. siasiensis</u> |
| 2. Interstices yellow or orange | 3 |
| Interstices white | <u>C. s. jensostergaardi</u> |
| 3. Columellar teeth short | <u>C. s. saulae</u> |
| Columellar teeth produced | <u>C. s. nugata</u> |

Cypraea saulae siasiensis differs from its most closely related subspecies, C. saulae nugata Iredale, in that the shell is larger; teeth are shorter and more well-defined; fossula broader, more depressed and not denticulated; interstices more fully tinted with deep orange that envelops the terminal ridge and anterior margin as well. The terminal collars are ivory to pale orange, while those of the typical species are chestnut brown.

It differs from Cypraea saulae saulae Gascoign as follows: it has a broader, smoother, less denticulate fossula; it is a smaller, narrower shell; the columellar teeth are shorter, and there are no multiple dorsal markings.

Cypraea saulae siasiensis is larger than C. saulae jensostergaardi Ingram, with shorter labial teeth; the base is beige rather than ivory; the interstices between the teeth are orange rather than white, and the general shell color is gray instead of ivory.

The holotype of Cypraea saulae siasiensis will be deposited in the Bernice P. Bishop Museum, Honolulu, Hawaii, and will bear the catalog number 212,719.



Figure 1: Map of Type Locality of Cypraea saulae siasiensis, subsp. nov.

The name siasiensis has been chosen because the type locality, Punnungan Island (approximately 5°32' N. Lat., 120°52' E. Long.) [see text fig. 1], is near Siasi, the largest of the islands in the Tapul Group and is indicated on most detailed maps. Specimens have also been collected at nearby Laminusa, another small island in the same group.

ACKNOWLEDGEMENTS

My warmest thanks go to the collectors in the Philippine Islands who sent these specimens for study; to Mr. and Mrs. John Q. Burch, who kindly made their library and comparative material available; and to Neill Cate for line drawings. The photographs are by Mr. Arthur Wilson and Mr. Ronald Kirkpatrick.

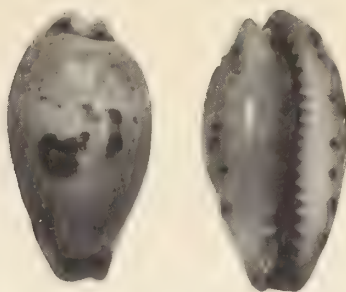


Figure 1



Figure 2



Figure 3



Figure 4



Figure 5

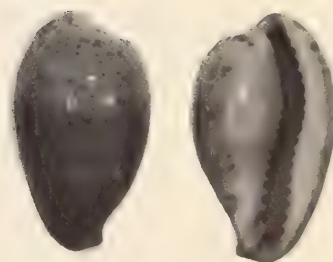


Figure 6

Dorsal and Ventral Aspect

Figure 1: *Cypraea saulae saulae* GASKOIN, 1843

Figure 2: *Cypraea saulae siasiensis* subsp. nov., Holotype

Figure 3: *Cypraea saulae siasiensis* subsp. nov., Paratype No. 1

Figure 4: *Cypraea saulae siasiensis* subsp. nov., Paratype No. 2

Figure 5: *Cypraea saulae siasiensis* subsp. nov., Paratype No. 3

Figure 6: *Cypraea saulae siasiensis* subsp. nov., Hypotype

(see table 1 for actual sizes of the illustrated shells)

LITERATURE CITED

- Allan, Joyce
1956. Cowry shells of world seas. Melbourne.
- Gaskoin, J. S.
1843. Description of a new *Cypraea*. Proc. Zool. Soc. Lond., p. 23.
- Ingram, W. M.
1939. A new cowry *Cypraea jensostergaardi*. Nautilus, vol. 52, no. 4, pp. 122-123, pl. 9, figs. 2-3.
- Iredale, Tom
1935. Australian cowries. The Australian Zoologist, vol. VIII, Pt. II, p. 125.
- Schilder, F. A. and M. Schilder
1938. Prodrome of a monograph of living Cypraeidae. Proc. Mal. Soc. Lond., vol. XXIII, Pt. 3, pp. 119-231.
- _____, _____
1952. Ph. Dautzenberg's collection of Cypraeidae. Halle, Germany, p. 158.

*Mopalia hindsi recurvans*, subspec. nov. (Amphineura)

by

EARL B. BARNAWELL

Department of Zoology and its Cancer Research Genetics Laboratory - University of California, Berkeley 4, California

(Plate 6)

In the course of an ecological study of the chitons of San Francisco Bay during February, 1952, to June, 1953, about 400 specimens of the genus *Mopalia* were collected and examined. Of that number 280 were *Mopalia hindsi* (Reeve, 1846). All specimens were measured, the gut contents examined and identified where possible, and the gonads were microscopically examined by a smear to determine maturity of ova or sperm; in addition, a microscopic examination of the bristles covering the girdle was made for each specimen.

It was discovered that 28 of the specimens of *Mopalia hindsi* had bristles which were characteristically different from the bristles described by LeLoup (1942) for *M. hindsi*. Upon closer examination, the 28 specimens were found to differ in the texture of the sculpturing of the valves as well as in color from typical specimens of *M. h. hindsi*.

The 28 specimens were also found to differ ecologically from *Mopalia h. hindsi*. These 28

specimens were found in the same areas as *M. h. hindsi* but were relatively plentiful at only 3 locations; these areas are located near the mouth of San Francisco Bay (see Table I). Typical *M. h. hindsi* were plentiful at all localities where the diverse forms were found. An analysis of the gut contents revealed that although the new form takes in about the same proportions of animal to plant material as typical *M. h. hindsi*, they ingest different kinds of animal material (Barnawell, 1960).

On the basis of these differences, it seems clear that a new subspecies has been discovered. It is my belief that it does not deserve specific rank because: (1) the distributional patterns of *Mopalia h. hindsi* and *Mopalia hindsi recurvans* are completely overlapping; (2) although there appears to be evidence that the two are using different foods, their food habits are very similar; (3) no completely sexually mature specimens of *Mopalia hindsi recurvans* were found.

Table 1

Station	North Latitude	West Longitude	Number of Specimens Found	Date Collected
San Francisco Aquatic Park	37°48'24-36"	122°25'24-30"	8	July 20, 1952; November 30, 1952; December 29, 1952; May 12, 1953; July 10, 1960.
Southwest Sausalito	37°51'06"	122°28'36"	9	July 9, 1952; July 21, 1952; April 5, 1953.
West Angel Island	37°51'30"	122°26'33"	1	April 18, 1953.
Tiburon	37°52'21"	122°27'00"	7	December 28, 1952; May 13, 1953; July 10, 1960.
Belvedere	37°52'06"	122°28'00"	2	December 14, 1952.
Yerba Buena Island	37°48'24-54"	122°21'00-42"	2	August 7, 1952.
End Richmond Breakwater	37°54'18"	122°23'12-24"	1	May 3, 1953.
Castro Rocks	37°55'54"	122°25'12"	1	April 16, 1953.

Mopalia hindsi recurvans Barnawell,
subspec. nov.

DESCRIPTION

The holotype is a partly mature male, eroded, anterior valve with eight low, rib-like elevations terminating in slits at the insertion in the girdle, the valve otherwise smooth and lacking sculpturing. The mid-valves with a single low, rib-like elevation extending from the beak of the valve anteriorly and diagonally to the slit at the insertions of the valve into the girdle. The lateral areas of the mid-valves possess low, smooth, minute projections which are scattered regularly over the surface grading from almost no projections to a series of low, smooth projections which run together to form a series of smooth, low ridges perpendicular to each other, producing a basket weave pattern.

The color of the valves is rust brown (Munsell R2.5 3/4) with olive green (Munsell G7.5 6/4) maculations which roughly parallel the growth lines. Color was determined by comparison with the Munsell Book of Color. Internally, the first mid-valve has a faint rust-colored (Munsell R7.5 8/4) flame radiating diffusely out from the beak.

The girdle is relatively narrow and clothed with a uniform scattering of soft amber bristles. The proximal third of the bristles is decorated with chitinous spines on the dorsal surface which are inserted in sockets in a fashion similar to the quill of a feather. The spines are strongly curved back through their terminal half so that they almost always point toward the base of the bristle. The tip of each chitinous spine is in turn provided with a calcareous spine inserted in a V-shaped socket. The calcareous spines are frequently lost so that often only the V-shaped socket remains.

Table 2

Specimen	Sex	Measurements (in millimeters)		Collected (see Table 1)	Date
		Length	Width		
Holotype	male	53	38	San Francisco Aquatic Park	July 10, 1960.
Paratype 1	immature	31	21	Tiburon	July 10, 1960.
Paratype 2	immature	38	28	San Francisco Aquatic Park	July 10, 1960.
Paratype 3	female	50	36	San Francisco Aquatic Park	December 29, 1952.
Paratype 4	female	30	20	Tiburon	May 13, 1953.

DESCRIPTION OF PARATYPES

(See Table II for measurements, sex, locality, and collecting dates.)

Paratype #1: Sculpture of valves more discrete with ribs on anterior valve outlined by a series of low, rounded projections. The posterior edge as well as the sutural line of each mid-valve are delineated by low, rounded projections. Coloration is more vividly green and brown than the holotype, with a series of chevron-shaped white markings on the mid-valves with the open end of the chevron pointing anteriorly (see Plate 6, fig. 2).

Paratype #2: Like paratype #1 in coloration and sculpture but lacking the chevron-shaped white markings (see Plate 6, fig. 3).

Paratype #3: Sculpture like that of holotype; color of valves predominantly olive green (Munsell G7.5 6/4) with maculations of rust-brown (Munsell YR2.5 3/4). Girdle is pinkish brown (Munsell YR2.5 8/4) and light in color. Specimen partly eroded.

Paratype #4: Eroded specimen like paratype #3 except the coloration of the girdle is dark brown and valves have larger blotches of rust-brown color (Munsell YR2.5 3/4) on a predominantly olive-green background. The second valve is almost entirely rust-brown. Anterior valve is covered by a bryozoan.

LOCALITY

Holotype from San Francisco Aquatic Park north of the Sea Scout Pier in the rocky intertidal area; 37°48'24"-36" N.; 122°25'24"-30" W. Other localities are shown in Table I.

DEPOSITION OF TYPES

Holotype USNM Cat. No. 613,139; Paratype #1 USNM Cat. No. 613,140; Paratype #2 California Academy of Sciences Type No. 12,141; Paratype #3 California Academy of Sciences Type No. 12,142; Paratype #4 British Museum (Natural History) No. 19,601,276.

DISCUSSION

The chitinous bristles which cover the girdle form the most prominent characteristic separating Mopalia hindsii recurvans from M. h. hindsii. In M. h. recurvans the bristles are soft and amber-yellow (Munsell YR10 7/10), very like those of M. h. hindsii in texture. The dorsal side of the bristles is decorated with the recurving chitinous spines usually over the proximal one third. The bristles of M. h. hindsii, although distributed similarly, are more flattened and the chitinous spines are more delicate and usually inserted only on the proximal fourth of the bristles; further, they show no tendency to recurve. The chitinous spines on the bristles bear calcareous spines on their tips which appear very similar to the ones in

the subspecies.

The valves are different in two respects from those of *Mopalia h. hindsii* — sculpture and coloration. Berry (1922) has described the sculpturing on the median valves of *M. hindsii* between the anterior granose rib and the posterior sutural thickening as "showing an interwoven basket-like pattern of varying distinctness". In *M. h. recurvans* the basket-like pattern is much less distinct and near the margins may be completely lacking.

The slits in the valves are identical to *Mopalia h. hindsii*, having eight in the head valve, one on each side of the median valves, and one on each side of the tail valve with an angular posterior sinus in the articulamentum.

In color there are some distinctive differences between *Mopalia h. hindsii* and *M. h. recurvans*. *M. h. recurvans* is mottled on the tegmentum with green and rust-brown flames which may appear striped parallel with the growth lines. The color of the tegmentum in *M. h. hindsii* is usually more dull. The interior of the median valves of *M. h. recurvans* usually has a distinct, large, pink (Munsell R5 7/8) flame which spreads from the beak both laterally and posteriorly. In *M. h. hindsii* the pink flame is confined almost entirely anteriorly to the sutural line. In the subspecies as in *M. h. hindsii* there exist some individuals with white markings on the valves as illustrated in Plate 6, fig. 2.

The radulae of members of the genus *Mopalia* differ from one another only in the relative size and massiveness of the teeth and do not provide an adequate basis for differentiation. The radulae of *M. h. hindsii* and *M. h. recurvans* appear identical.

ACKNOWLEDGMENTS

I wish to express my indebtedness to Dr. Kenneth B. DeOme for support, both financial and moral.

LITERATURE CITED

- Barnawell, E. B.
1960. The carnivorous habit among the Polyplacophora. *The Veliger*, vol. 2, no. 4, pp. 85-88.
- Berry, S. S.
1922. Fossil chitons of Western North America. *Proc. Calif. Acad. Sci.*, vol. 11, no. 18, pp. 399-526.
- LeLoup, E.
1942. Contribution à la connaissance des Polyplacophores. I. Famille Mopaliidae Pilsbry, 1892. *Mém. Mus. Hist. Nat. Belg.* Series 20, Fasc. 25.
- Munsell Color Company, Inc.
1929-1942. *Munsell book of color*. Baltimore, Maryland.



Explanation of Plate 6

- Figure 1: *Mopalia hindsii hindsii* (REEVE, 1846). 38 mm. long, 30 mm. wide. Figure 2: *Mopalia hindsii recurvans* BARNAWELL, subsp. nov., Paratype 1; color variant; 31 mm. long, 21 mm. wide. Figure 3: *Mopalia hindsii recurvans* BARNAWELL, subsp. nov.; Paratype 2; 38 mm. long, 28 mm. wide. Figure 4: Typical bristles from the girdle of *Mopalia hindsii hindsii* (REEVE, 1846). Figure 5: A single bristle from the girdle of *Mopalia hindsii recurvans* BARNAWELL, subsp. nov., Paratype 3. Figure 6: A row of bristles from the peripheral edge of a young (20 mm. long, 15 mm. wide) specimen of *Mopalia hindsii recurvans* BARNAWELL, subsp. nov. Collected at Sausalito, May 5, 1953. Figure 7: A single bristle from the same specimen showing attachment of the chitinous spines to the larger bristle and the calcareous tip on one spine to the right.

(Note: the photomicrographs, figures 4 to 7 inclusive, were taken by the author with phase contrast)



Figure 1

Figure 2

Figure 3



Figure 5

100 μ



Figure 4

100 μ



Figure 6

100 μ



Figure 7

100 μ

A New Panamic Species of *Trivia*

by

FAYE B. HOWARD & GALE G. SPHON, JR.

Conchological Club of Southern California, Los Angeles 7, California

(Plate 7)

On May 14, 1957, the first known specimen of a new *Trivia* was found in the beach drift just south of Punta Final, Baja California, Mexico. The following year, again in May, two living specimens were found in the same locality. They were obtained in a small north-east-facing cove with turbulent water near the extreme low tide mark on the underside of large stones. They were found at a point where the fairly steep, rocky rubble leveled out and was changing from solid rubble to scattered rocks set in medium-fine sand. Other mollusks found under the same conditions were *Hyalina californica* (Tomlin, 1916) and *Diodora inaequalis* (Sowerby, 1835).

On March 18, 1960, while the senior author was collecting at the south end of Bahia de Los Angeles, Baja California, Mexico, one dead specimen was found. The beach was almost identical in composition and exposure with that of the Punta Final cove. Associated mollusks were: *Hyalina*, *Diodora*, *Trivia solandri* (Sowerby, 1832), *Trivia sanguinea* (Sowerby, 1832), *Heliacus bicanaliculatus* (Valenciennes, 1832), and *Mitra solitaria* C. B. Adams, 1858.

On May 12, 1960, another try at Punta Final for more specimens proved futile. The cove had filled with shifting sand up to the mid-tide level, completely covering the rocky area where the live specimens had been taken. With only one low tide period to work, similar ecological niches could not be located.

It seems probable that a careful search at Bahia San Luis Gonzaga for this species would be rewarding as the associated mollusks are all found there and some areas located there exhibit quite similar ecological aspects.

Trivia (Pusula) elsiae, spec. nov.

HOLOTYPE:

Shell small, thin, ovate in shape; olivaceous in color; the ribs smooth and flattened, about half the diameter of the interspaces, 18 in num-

ber with 8 of them intercalary, the remaining 10 pass over the columella where they are knobbed, the two short anterior ones most heavily so; the ribs of the outer lip number 12 and are produced as teeth on the outer lip; all ribs fading about two-thirds of the distance up the shell; the dorsum is oval and completely smooth; the spire is distinctly visible when viewed from the dorsal surface; three whorls plus body whorl can be seen. Length 7 mm. Width 6 mm. Height 4 mm. (Plate 7, fig. 1)

PARATYPE I:

Dead specimen collected at the type locality on May 14, 1957. This is the first collected specimen of *Trivia elsiae* and differs from the holotype in having 12 ribs pass over the columella and only two intercalary ribs. It differs also in having 13 teeth on the outer lip. Length 7 mm. Width 6 mm. Height 4 mm. (Plate 7, fig. 2)

PARATYPE II:

Live specimen collected with the holotype and differs from it in being slightly thinner, in having one more rib produced as a tooth on the outer lip, and in showing no intercalary ribs. Length 7 mm. Width 5.5 mm. Height 4 mm. (Plate 7, fig. 3)

HYPOTYPE I:

Dead specimen collected at Bahia de Los Angeles on March 18, 1960, differs from the holotype in having 12 ribs cross the columella and only three intercalary ribs. It also differs in having 13 teeth produced on the outer lip. (Plate 7, fig. 4)

COMPOSITE DESCRIPTIONS:

Shell small, thin, ovate in shape; live speci-

mens olivaceous in color; ribs smooth and flattened, about half the diameter of the interspaces, 14-18 in number, 0-8 intercalary, 10-12 passing over the columella where they are knobbed, the two short anterior ones most heavily so; ribs of the outer lip 12 or 13 in number and are produced as teeth on the outer lip; all ribs fading out about two-thirds of the distance up the shell; the dorsum oval and completely smooth; the spire of three whorls plus the body whorl distinctly visible when viewed from above. Length 7-8 mm. Width 5.5-7 mm. Height 4-5.5 mm.

TYPE LOCALITY:

The type locality is Punta Final, Baja California, Mexico, approximately ten miles south of Bahia San Luis Gonzaga. Latitude 29°45' North; Longitude 114°25' West.

DISCUSSION:

Of the Panamic species of the genus *Trivia*, *T. elsiae* most closely resembles *T. galapagensis* (Melvill) which is endemic to the Galapagos Islands. These two species are the only known Panamic *Trivias* which have a smooth dorsum. *T. elsiae* can easily be separated from *T. galapagensis* by the unconcealed spire.

Of the mainland species of *Trivia*, *T. elsiae* most closely resembles *T. sanguinea* (Sowerby), but it may be separated from that species by its less numerous ribs, lack of a dorsal blotch, completely smooth dorsum, and unconcealed spire.

Trivia elsiae might be thought to be a juvenile of some other species of *Trivia* with incompletely formed dorsal ribs. Specimens of *T. solandri* (Sowerby), however, have completely formed ribs in the bulla stage before the outer lip is turned, as shown in one specimen col-

lected by the senior author at the type locality of *T. elsiae* and in five specimens collected by Mr. Mark Rogers at Puertecitos, Baja California, Mexico, on April 13, 1960. All of these young specimens are white in color lacking the typical brownish-pink of the adult *T. solandri*, whereas all known specimens of *T. elsiae* are colored and appear to be adults. The adults of *Trivia* found in the Panamic area are compared in the following key.

KEY TO THE PANAMIC *TRIVIA*

- | | |
|--|-------------------------------|
| 1. Endemic to the Galapagos Islands | 2 |
| Not endemic to the Galapagos Islands | 3 |
| 2. Dorsum smooth | <i>galapagensis</i> (Melvill) |
| Ribs crossing the dorsum | <i>rubescens</i> (Sowerby) |
| 3. Shell white in color | 4 |
| Shell not white or greyish in color | 5 |
| 4. Ribs on the dorsum beaded | <i>acutidentata</i> (Gaskoin) |
| Ribs on the dorsum not beaded | <i>panamensis</i> Dall |
| 5. Ribs not interrupted by a dorsal furrow | 6 |
| Ribs interrupted by a dorsal furrow | 7 |
| 6. Ribs running across the dorsum; red splotch on dorsum | <i>sanguinea</i> (Sowerby) |
| No ribs on dorsum, dorsum smooth, no red splotch | <i>elsiae</i> Howard & Sphon |
| 7. Shell 12 mm. or over in length | 8 |
| Shell under 12 mm. in length | 9 |
| 8. Shell rounded in outline and base flattened | <i>radicans</i> (Lamarck) |
| Shell oval in outline and base not conspicuously flattened | <i>solandri</i> (Sowerby) |
| 9. Shell small with a dorsal splotch | <i>pacifica</i> (Sowerby) |
| Shell with no dorsal splotch | 10 |
| 10. Ribs on the dorsum beaded | <i>californiana</i> (Gray) |
| Ribs on the dorsum not beaded | <i>atomaria</i> Dall |

Explanation of Plate 7

Figure 1: *Trivia elsiae* HOWARD & SPHON, spec. nov., Holotype.

Figure 2: *Trivia elsiae* HOWARD & SPHON, spec. nov., Paratype I.

Figure 3: *Trivia elsiae* HOWARD & SPHON, spec. nov., Paratype II.

Figure 4: *Trivia elsiae* HOWARD & SPHON, spec. nov., Hypotype.

Figure 5: *Trivia sanguinea* (SOWERBY, 1832).

(Each figure shows the dorsal and ventral aspect of the same specimen)

For actual sizes see text.

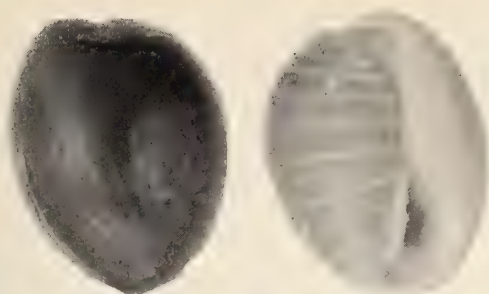


Figure 1



Figure 2

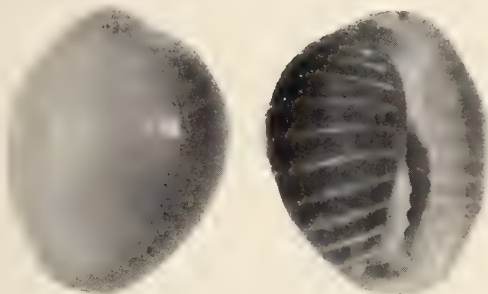


Figure 3

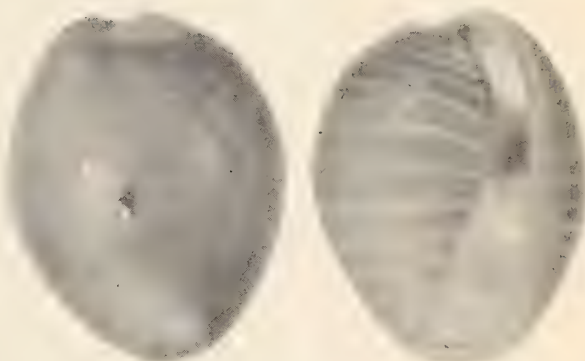


Figure 4



Figure 5

DISTRIBUTIONS OF TYPES:

The holotype is deposited in the San Diego Museum of Natural History, San Diego, California, Number 45,924. Paratypes I and II and hypotype I are in the private collection of the senior author.

NAME:

This new species of Trivia is named in honor of Elsie M. Chace for her long-standing interest in conchology and for the unstinting help which she has given the authors over the many years they have known her.

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Further Remarks on the Interpretation of the Mollusca

by

W. PATRICK MILBURN

(Plate 8)

Last year, in a paper titled, "Neopilina and the interpretation of the Mollusca" (Milburn, 1959), I made an attempt to outline the relationships of the classes of mollusks based in the largest part on gill characteristics. A particular orientation towards classification and the recognition of relationships was developed taking the point of view that all of our systems and phylogenies should always be recognized to be constructs made from the available data. Since that discussion, further study has forced correction of some of the propositions and has reinforced others. Both the correction and the reinforcement have made more clear the problems involved in these studies. Further, additional study of procedure has led to ways of improving these constructs. The discussion will concern the topics in this order: 1) the correction of relationships and its importance; 2) the reinforcement of the previous views and its significance; and 3) the suggested improvements in the methods of making these constructs.

I. Corrections of Postulated Relationships.

Without any substantial evidence, the conclusion was stated that "Neopilina is flat and from a form like this it is easy, at least in principle, to derive the chitons and solenogastres" (Milburn, l. c., p. 26). This was a contradiction of the methodology, and it is now clear that only in principle would it be possible to derive these groups from something like Neopilina. Further evidence suggests that not all of its characters are exceedingly primitive.

The error of my previous conclusion was made clear to me in a discussion with Drs. Donald P. Abbott and C. M. Yonge in which it was suggested that the ancestral mollusk may have been much more primitive than Neopilina. In support of this, it was pointed out that the state corresponding to a veliger in the chiton has several shell plates right from the start and never a single plate as in the higher mollusks. The unlikelihood of a single shell being broken transversely into eight plates was also

mentioned.

Investigating this possibility, a review of the characters of Neopilina in the Galathea Report was found to strongly support the position of the above discussion. Neopilina differs from chitons and is similar to the higher mollusks in 1) possessing a single shell plate with growth on the edge (Lemche, 1959, p. 64); 2) in possessing a larval shell similar in some respects to that of gastropods (Lemche, 1957; Lemche, 1959, p. 64); and 3) in having a shell of three distinct shell layers, a periostracum, a prismatic and a nacreous layer (Lemche, 1957, p. 64). The chitons are quite different in 1) having the shell of eight plates growing by transverse growth; and 2) having the shell of two shell layers, a tegmentum, and an articulamentum. [After the reading of this paper at the thirteenth convention of AMU-PD, it was mentioned to me that some new work suggests that one of the layers of a chiton's shell may actually consist of two layers; I have not yet seen this work but the two layers are certainly not as clearly marked as in higher mollusks.] Finally, 3) in having a larval shell composed of several plates (Heath, 1899). A comparison of the veligers of these forms (Figure 1) demonstrates the similarities of Neopilina, at least in the shell, to the veliger and its differences from the chiton larva. Further, Neopilina seems similar to bivalves and gastropods in having its lateral nerve cords meeting below the rectum (Lemche, 1959, p. 50).

Thus, quite differently from my suggestion of last year, these data suggest two major concentrations of characters, the Amphineuran forms and the higher mollusks plus the Monoplacophora. Although I was not aware of it at the writing of last year's paper, such a division as just proposed had already been suggested long ago. Grobben (1905) may have been the first to divide the mollusks into these groups, calling them Amphineura and Conchifera, which, however, he considered classes (l. c., p. 586). Grobben credits Gegenbauer with the proposal for the unification of the gastropods, scaphopods, bivalves, and cephalopods in the Conchifera (l. c., p. 591). In 1926 Naef raised Grobben's classes to subphyla (Naef, 1927, p. 87).

Lemche attacks this division into Amphineura and Conchifera on the grounds that Neopilina has both the nervous system of the Amphineura and the shell of the Conchifera, thus breaking the principal characters (Lemche, 1959, p. 68).

This criticism of the definition seems well taken, as does the criticism of uniting all of the "conchiferans" into a class. However, Lemche's conclusion that we should regard all of these groups as independent classes arising from some common ancestor is not consistent with the data he has given. Clearly, the Monoplacophora, Cephalopoda, Gastropoda, Scaphopoda, and Pelecypoda form a supergroup based on at least the characters of the distinctly three-layered shell, the similarities of the larval shell, perhaps the features of the posterior nervous system, and probably several more. The characters as stated for the Conchifera may have to be revised, but this division still seems to be supported, with the Monoplacophora not being the most primitive group of mollusks but rather being the group of "conchiferan" mollusks with the most primitive characters.

Whether or not the solenogastres will belong in the subphylum with chitons cannot yet be stated. They both have one set of kidneys, but the significance of this is difficult to assess since this seems to have developed independently in both the dibranchiate cephalopods and in the gastropoda-pelecypoda group (Morton, 1958, p. 65). Moreover, the kidney structure is very different in solenogastres and chitons so that they may well represent separate lines. In solenogastres, the two gonads are separate and empty through the kidneys out a single pore. In chitons the gonads are fused into one which dumps out of two pores separately from the kidneys (Goodrich, 1946, p. 336). In solenogastres the nervous system seems somewhat more complex and condensed than in chitons. Clearly, more information is needed, particularly of development, if a decision is to be reached. If it finally looks as though these groups ought to be separated, I hope that names are chosen which will agree with Conchifera better than Amphineura does as far as some similar character is concerned.

Interestingly, gill structure does not give the help at this level that it does when considering the relationships among the classes of higher mollusks. In chitons (Yonge, 1939, p. 378) and in Neopilina (Lemche, 1959, pl. 46, fig. 143) the water flows first over the refreshed blood as in gastropods and pelecypods. They are different from these more advanced groups in lacking gill-bars. In the cephalopods the condition is quite different, with gill-bars present (opposite in orientation to the gastropod-pelecypod scheme) and the water flows first over the de-

pleted blood (Milburn, 1959, p. 27). Evidently, the condition in Neopilina and chitons represents the primitive condition, that of the gastropods and pelecypods the addition of gill-bars, and that of the cephalopods a reorientation and addition of gill-bars.

In the previous paper, the placing of the Monoplacophora as ancestral was clearly caused by a conception that Neopilina is primitive. This was a serious logical error which ran in direct contradiction to the method outlined for formulating constructs. We are all too much in danger of being overly impressed by the idea of the primitive. It may lead us to continually recognize those features that are of a primitive nature, while not recognizing those features that are advanced or divergent. The point should be emphasized that we should not regard any form as totally primitive, even if it possessed a majority of primitive traits. All organisms have diverged to some extent. If we do not take care in our thinking, we can slip into a kind of Idealism. Doubtless, Neopilina retains many of the primitive features of the phylum, but its similarities to the "conchiferan" forms also indicate how far in the differentiation of the phylum the primitive gill, segmentation and nervous system were retained.

II. Reinforcement of Previous Conclusions.

In the previous paper, I suggested, on the basis of gill structure, that the gastropods and pelecypods belonged in the same supergroup, which should also contain the scaphopods (Milburn, l. c., p. 25). It is interesting to note that Grobбен had set up the Prorhipidoglossomorpha in 1905 (Grobбен, l. c., p. 591) and Naef the Heteroneura in 1926 to contain these three groups in opposition to the cephalopods (Naef, l. c., p. 88). Besides having the water flowing first over the refreshed blood (when gills are present) [Milburn, l. c., p. 26], the following of Naef's characters also seem rather strong (Naef, l. c., p. 89): 1) a primary union of the pleural, cerebral, and pedal ganglia; 2) the visceral commissure being up under the hindgut and in the groove between the head and the roof of the mantle cavity; 3) the reduction of the anal complex to one segment, opposed to two segments in the cephalopod *Nautilus*; and 4) the release of the sex products through the kidneys.

(This last character is true in gastropods, scaphopods, and protobranch and filibranch pelecypods but not in the eulamellibranchs [Yonge, l. c., p. 326].)

A more exact position of the scaphopods is not certain. Naef mentions that their nervous system is similar to pelecypods, particularly in having a lengthening of the cerebro- and pleural pedal connective (Naef, l. c., p. 64). The larval shell is a cap-like plate in scaphopods and pelecypods (Schrock & Twenhofel, 1953, p. 494). Plate (1922, p. 451) mentions that they are close to the primitive gastropods in that they still have a head with a mouth tube, a pharynx with radula and jaws, a single shell, and an unpaired gonad with discharge [through the right kidney]. They thus share important characters with both gastropods and pelecypods, and it is not clear to which of these two groups they are more closely allied, if, indeed, to either.

If these relationships and clusters of characters are placed in a taxonomy, the form is as follows:

Phylum Mollusca

subphylum Amphineura (perhaps separate subphyla will be required for chitons and solenogastres)

Class Polyplacophora - chitons

Class Aplacophora - solenogastres

subphylum Conchifera (Gengenbauer, Grobбен, Naef)

superclass ***** (name not proposed)

Class Monoplacophora

superclass ***** (the Prorhipidoglossomorpha was not for a superclass; the Heteroneura also does not seem to have been clearly proposed. There is a chance, then, that a descriptive name can be formed for this group)

Class Gastropoda

Class Scaphopoda

superclass ***** (name not proposed)

Class Cephalopoda

It is hoped that helpful, descriptive names for the superclasses and for the subphyla of chitons and solenogastres (if they are sufficiently distinct) will be proposed and not vague terms or terms reflecting some contrived phylogenetic speculation. The suggested relationship of the classes is indicated in figure II, plotted against the fossil record of the classes (Nicol, Desbrough, & Solliday, 1959).

III. Improvements in the Method.

It is my feeling that all of the products of the human mind are symbolic constructs of one sort or another. Accordingly, that is certainly the case with systematics. Further, it is my feeling that most classifications are in reality based on a large number of characters, included in the total form perceived by the person, whether these are verbalized or even recognized. It is perhaps not clear that this "totalizing" is going on at the level of genus or family, and it is not necessary that it be recognized there. When relationships are very distant or obscure so that the mind cannot easily derive the characters, it does become necessary to verbalize all of the characters so that we may formulate classifications and perceive relationships. As an additional gain, by listing all of the available evidence, the process becomes more objective, more verifiable, and we gain a much greater ability to predict since we will have a greater body of common characters.

As we have seen, the higher taxonomy of these German zoologists anticipated the evidence derived from gill-structure. Their work was not generally adopted, particularly in the English-speaking part of the world. Perhaps it was still too far from the degree of certainty hoped for by taxonomists.

We may ask, "How many characters must we use in our constructions to gain a high enough level of probability to institute proper subphyla?" Michener and Sokal (1957, p. 160), who have applied mathematical probability to a group of insects suggest that the number of characters, to be reliable, should not be less, and need not be more, than 60. Many characters can be taken from each system and the results totaled by a desk computer. Olson and Miller (1958, p. 58) have suggested that statis-

tical methods be utilized to analyze the correlation of characters in an organ system or region of the body. This could prove of aid in evaluating characters and in providing developmental characters. These methods offer a great deal of hope and lead to the proposal that such mathematical investigations be attempted for the Mollusca. Not only might this lead to a reliable set of subphyla and superclasses for the phylum, but this mode of analysis might well help us in analyzing the relationships within the Pelecypoda, Mesogastropoda, Opisthobranchia, and other groups.

The point deserves to be emphasized at this time that, even if statistical means are employed, this in no way detracts from the efforts of the taxonomist. He still must recognize characters and perceive relationships, even if the data is organized to help him. The task of classification is a creative, human endeavor, whether one uses large amounts of information or not. One is simply more certain of the result if a large number of characters are used.

Summary: 1) Neopilina, while possessing numerous primitive traits, seems to be less primitive in some respects than the chitons and to be related to the mollusks with a shell plate in three layers; 2) the character distribution of chitons and solenogastres is not yet certain, and two subphyla may be necessary for these groups; 3) the evidence suggests that a subphylum for the mollusks with a single larval shell and an adult shell in three layers divides naturally into three superclasses, one for the Monoplacophora, one for the Cephalopoda, and one for the Gastropoda, Pelecypoda, and Scaphopoda; 4) it is urged that statistical analyses of the characters of molluscan groups be carried out in order to clarify relationships and to increase our ability to make predictions.

Explanation of Plate 8

Figure 1: *Neopilina* larval shell compared with chiton larva and gastropod veliger.

Figure 1 a: Chiton trochophore (example of trochophore stage common to most mollusk groups)

Figure 1 b: Stage in chiton development corresponding to veliger indicating the developing eight shell plates [a and b from Heath]

Figure 1 c: Apical part of shell of *Neopilina* with larval shell [from Lemche, 1957]

Figure 1 d: Veliger of gastropod (*Crepidula*) [from Emily Reid]

Figure 2: Probable higher relationships of the classes of mollusks plotted against their record in time and indicating a possible "ancestral mollusk" [redrawn with modifications from Nicole et al.]

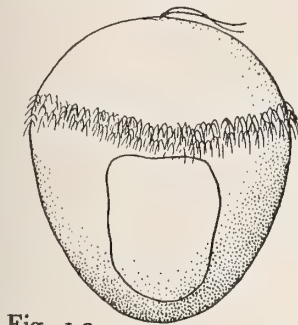


Fig. 1 a

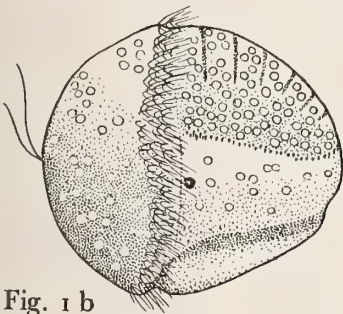


Fig. 1 b

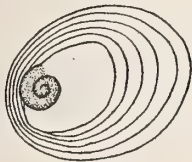


Fig. 1 c

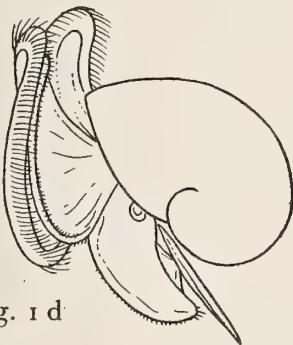


Fig. 1 d

Cenozoic							
Cretaceous							
Jurassic							
Triassic							
Permian							
Carboniferous							
Devonian							
Silurian							
Ordovician	Cephalopoda	Gastropoda	Scaphopoda	Pelecypoda	Monoplacophora	Polylacophora	Aplacophora
Cambrian							
Pre-Cambrian							

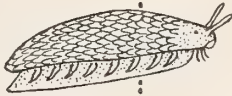


Figure 2

Explanation of markings:

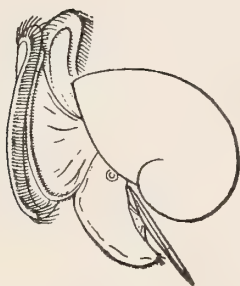
- Complete fossil record with or without recent examples. _____
- Gap in fossil record between fossils and recent examples. - - - - -
- Fossil record absent; relationships indicated represent a construct.

ACKNOWLEDGEMENTS

My sincere thanks are due to Dr. Myra Keen for her kind assistance and suggestions and to Dr. Donald Abbott for both the opportunity to meet Dr. C. M. Yonge and for his helpful comments. While I am indebted to these persons, the thoughts and suggestions are my own, and for these I take full responsibility.

LITERATURE CITED

- Goodrich, E. S.
1946. The study of the Nephridia and genital ducts. *Quart. J. Micro. Sci.*, vol. 80, pp. 367-390.
- Grobbe, K.
1905. Revision of C. Claus *Lehrbuch der Zoologie*. Hessen.
- Heath, H.
1899. The development of *Ischnochiton*. *Zool. Jahr.*, vol. 12, pl. 5, fig. 51-52.
- Lemche, H.
1957. A new living deep-sea mollusc of the Cambro-Devonian class Monoplacophora. *Nature*, vol. 179, pp. 413-416, pl. 4, fig. 2.
- Lemche, H. & K. G. Wingstrand
1959. The anatomy of *Neopilina galathea*. *The Galathea report*, vol. 3, pp. 9-72.
- Michener, C. D. & R. R. Sokal
1957. A quantitative approach to a problem in classification. *Evol.*, vol. 11, pp. 130-162.
- Morton, J. E.
1958. *Molluscs*. London.
- Naef, A.
1927. Studien zur generellen morphologie der Mollusken. 3. Teil: Die typischen Beziehungen der Weichtierklassen untereinander und das Verhältnis ihrer Urformen zu anderen Cölomaten. *Ergeb. Forts. der Zool.*, vol. VI, pp. 27-124.
- Nicol, D., G. A. Desborough, & J. R. Solliday
1959. Paleontologic record of the primary differentiation of some major invertebrate groups. *J. Wash. Acad. Sci.*, vol. 49, pp. 351-366.
- Olson, E. C. & R. L. Miller
1958. *Morphological Integration*. Univ. Chi. Plate, L.
1922. *Allgemeine Zoologie*, first part (June).
- Schrank, R. R. & W. H. Twenhofel
1953. *Principles of invertebrate paleontology*. New York.
- Yonge, C. M.
1939. On the mantle cavity and its contained organs in the Loricata. *Quart. J. Micro. Sci.*, vol. 81, pp. 367-390.



An Abalone Lacking Respiratory Apertures

by

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(Contribution from the Scripps Institution of Oceanography, New Series)

University of California,

La Jolla, California

(Plate 9)

The discovery of a juvenile red abalone, *Haliotis rufescens* Swainson, 1822, characterized by a complete absence of respiratory apertures seems worthy of a published note. The imperforate specimen was collected together with a number of normal specimens on a beached kelp holdfast [*Macrocystis pyrifera* (Linn.) Agardh, 1771] at Pacific Beach, California, in October, 1959 (Figure 1, top). Normally, a pallial cleft develops and aperture formation commences when the juvenile abalone is approximately two millimeters long. Dissection of this specimen, however, revealed that no cleft had been formed in the mantle. The general perfect condition of shell and body tissue lends support to the interpretation that the absence of apertures and pallial cleft is the result of mutation rather than local injury.

Specimens of various abalone species have been collected which apparently had lost the ability to create apertures. In all cases, however, the cessation of aperture formation was found to have been brought about by a mechanical injury to the mantle and shell. In such specimens apertures had been formed in the young stages but were not formed subsequent to injury. Observation of this phenomenon in occasional specimens of the black abalone has led some investigators to describe subspecies of the form (Keep, 1935). *Haliotis cracherodii holzneri* Hemphill, 1907, and *H. c. imperforata* Dall, 1919, are two of the so-called subspecies appearing in older literature (Abbott, 1954).

Prosobranch gastropods possessing respiratory apertures or slits (archaeogastropodan families Pleurotomaridae, Scissurellidae, Haliotidae, and Fissurellidae) are considered primitive types (Yonge, 1947). These gastropods create a water current which enters the mantle cavity from beneath the shell and which, after bathing the gills and picking up wastes or sex products, leaves via the respiratory apertures. An abalone lacking apertures must elevate the shell considerably to maintain a respiratory current. A mutation of the kind responsible for the loss of the ability to create apertures through the disappearance of the pallial cleft may have provided the necessary step leading to the evolution of the more advanced non-apertured gastropods.

LITERATURE CITED

- Abbott, R. T.
1954. American seashells. D. Van Nostrand Co., Inc., New York.
- Keep, J. and J. L. Bailly, Jr.
1935. West Coast shells. Stanford University Press, Stanford, California.
- Yonge, C. M.
1947. The pallial organs in the Aspidobranch Gastropoda and their evolution throughout the mollusca. Philosoph. Trans. of the Royal Society. Ser. B, vol. 232, pp. 443-518.

Explanation of Plate 9

Figure 1: Imperforate shell of *Haliotis rufescens*.

Figure 2: Foot and viscera of the same specimen.

Figure 3: Normal shell of the same species of abalone.

Figure 4: Foot and viscera of the normal specimen. Note the pallial cleft (arrow). It is non-existent in the imperforate specimen. All figures on the left are from black and white photographs, while those on the right are from color photographs. Illustrations four times natural size.

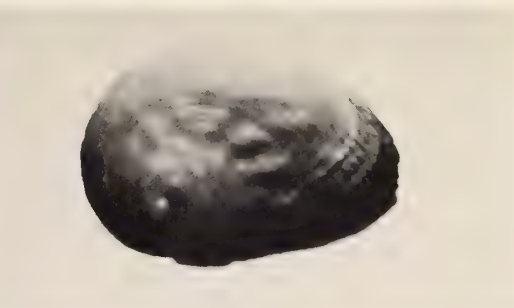


Figure 1

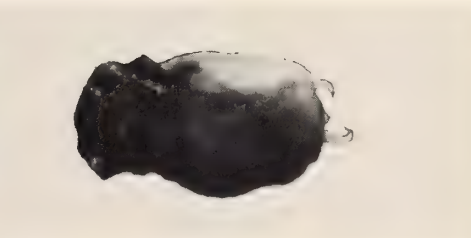
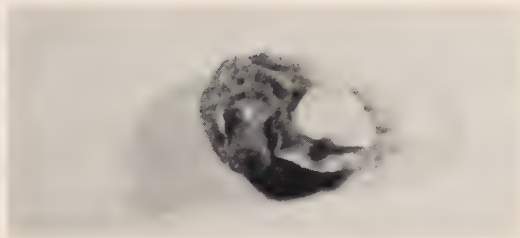


Figure 2

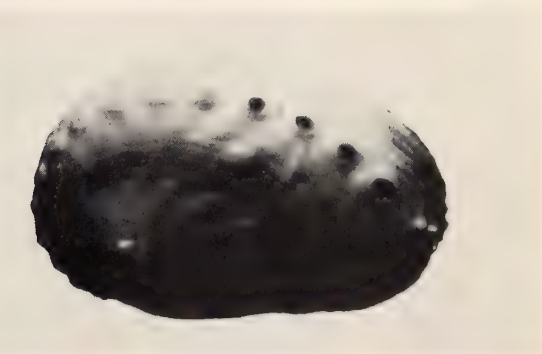


Figure 3

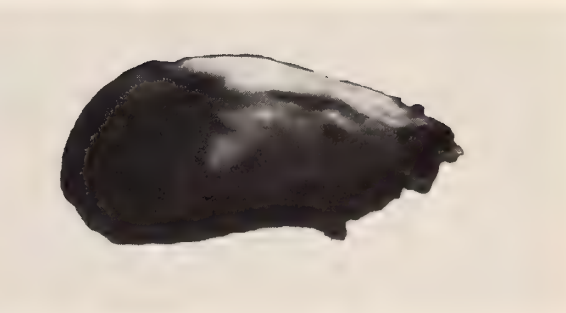


Figure 4

Notes & News

Rare and Little-Known Opisthobranch Mollusks from the West Coast of North America

by

JOAN E. STEINBERG

San Francisco, California

In August, 1960, I visited the University of Washington Laboratories at Friday Harbor, Washington, to obtain information to be included in a key to the Opisthobranchs of the West Coast of North America covering the region from Southern California to Vancouver Island (The Veliger, in press). At that time I was presented with a single specimen of a nudibranch which was assumed by the collectors to be Corambe pacifica MacFarland and O'Donoghue, 1929. Upon closer examination, however, it proved to be a member of the genus Corambella Balch, 1899. Heretofore, no species of Corambella have been reported from this area. Until further material is available, it is advisable to designate this form as Corambella sp. It was reported to occur on floating brown kelp in association with the bryozoan Membranipora.

Three other opisthobranchs which have not been described before, at least from the areas in which they were collected, are worthy of note. A member of the family Philinoglossidae (order Acochlidae) occurs in the alga Endocladia on the rocks north of Dillon Beach, Marin County, California. No other representatives of this peculiar order have been reported from the West Coast of North America.

A small species of the genus Okenia has been collected at Berkeley Yacht Harbor and at Palo Alto Yacht Harbor and has been dredged near Point Richmond, all in San Francisco Bay. Okenia vancouverensis (O'Donoghue, 1921) is the only member of this genus described from the West Coast of North America, but on the basis of external characters it is markedly different from the California species. Until further work is done, the animals from California are best designated as Okenia sp.

The small cuthonid eolid nudibranch, occasionally abundant on campanularid hydroids in San Francisco Bay and Monterey Bay, has been known locally as Embletonia sp. Alder and Hancock, 1851. However, it belongs to the genus Tenellia A. Costa, 1866, but until the detailed anatomy of its reproductive system is worked out, its exact relationship to other species in this genus cannot be determined.

Range Extension and Synonymy for

Mitra nigra (SCHRÖTER, 1788)

by

JEAN M. CATE

Conchological Club of Southern California,
Los Angeles 7, California

A major range extension for Mitra nigra (Schröter, 1788) was brought to light by the September 1959 deep-water dredgings of the Pele Expedition in Hawaii. A single live specimen was dredged on a coral and sand bottom from 75 fathoms in Keehi Lagoon, Oahu (21°N. Lat., 157°W. Long.). Although the outer lip of this specimen had been badly broken, it was in the process of repair by the mollusk and enough of the shell remains in perfect condition to make possible a positive identification of the species.

Mitra nigra has previously been recorded from Tasmania, from New South Wales, and from various localities in New Zealand (Suter, 1913; Iredale, 1931; Allan, 1950; Cotton, 1957, 1959), from the island of Anaa in the south Pacific Ocean (Dautzenberg and Bouge, 1933), and (questionably) from "Guinea, India and Greenland" (Reeve, 1844). India can apparently be disregarded as a valid locality, as M. nigra is not represented in the collection of shells in the Indian Museum at Calcutta, although beach-worn specimens of a very similar species, Vicimitra prosphora Iredale, 1929, are recorded there from Bombay, Karachi, and the Persian Gulf (Ray, 1954). It has not been previously recorded from Hawaii, either living or fossil, in any of the available references from that area (Garrett, 1880; Pilsbry, 1920; Ostergaard, 1928; Edmondson, 1946; Bryan, 1956, 1958; Tinker, 1958).

Among the reliable localities of record, Anaa in the Tuamotu Archipelago, 3,000 statute miles southeast of Hawaii, is the closest approach to the recently discovered collecting station on Oahu. To the nearest degree, this results in a range extension of approximately 44 degrees of longitude westward and 11 degrees of latitude northward.

Discounting Reeve's unverified records of this species from Guinea and Greenland, Mitra nigra still remains one of the widest-ranging species of this genus known. Its center of population is apparently South Australia, where it is spoken of as "common" (Cotton, July 1960 personal communication).

Mitra nigra has undergone many changes in nomenclature since its first description by Chemnitz in 1788, subsequently validated by Schröter in the same year. The synonymy follows:

- 1788 Voluta nigra
Chemnitz, Conch. Cab., X, p. 168, pl. 151, fig. 1430, 1431.
- 1788 Voluta nigra Chemnitz
Schröter, Namen Register, p. 115.
- 1822 Mitra carbonaria
Swainson, Bligh Catalogue, Ex. Conch. App.
- 1822 Mitra melaniana
Lamarck, Anim. s. Vert., VII, p. 314.
- 1844 Mitra nigra Chemnitz
Reeve, Conch. Icon., pl. 5, f. 33.
- 1844 Mitra badia
Reeve, Conch. Icon., pl. 20, f. 157 (Juvenile of M. nigra).
- 1854 Volutomitra digna
A. Adams, Zool. Proc., p. 135.
- 1882 Mitra melaniana Lamarck
Tryon, Man. Conch., IV, p. 127, pl. 37, fig. 118.
- 1931 Vicimitra contermina
Iredale, Rec. Austr. Mus., 1936, Vol. 19, pl. 4, fig. 15.

I particularly wish to thank Clifton S. Weaver of Honolulu for the opportunity to identify and study this shell from the Pele Expedition; Mrs. Thelma Hartley of Melbourne for her help in tracing some of the Australian references, and Mr. and Mrs. John Q. Burch for access to their reference collection and library.

LITERATURE CITED

- Allan, Joyce
1950. Australian shells, Georgian House, Melbourne. 470 pp., 44 pls., p. 182
- Bryan, Edwin H., Jr.
1956. Check list of Hawaiian Miters. Hawaiian Shell News, vol. 4, no. 4, pp. 38-39.
- _____, _____
1959. Provisional check list of Gastropods recorded from the Hawaiian chain. No. 33, Mitridae; ibid., vol. 7, no. 12, supp. pp. 23-28.
- Cotton, Bernard C.
1957. Family Mitridae. Roy. Soc. So. Austr. publ. no. 12, p. 3.
- _____, _____
1959. South Australian Mollusca: Archeogastropoda. Hawes, Adelaide, 449 pp., 1 pl., p. 306.
- Dautzenberg and Bouge
1933. Les mollusques testacés marins des établissements français de l'Océanie. Journ. de Conchyliologie, vol. 77, no. 2, p. 178.
- Edmondson, Charles H.
1946. Reef and shore fauna of Hawaii. B. P. B. Mus. Spec. Publ. No. 22; Honolulu, 381 pp., p. 128.
- Garrett, Andrew H.
1880. On Polynesian Mitridae. Journ. Conch., vol. 3, pp. 3-8.
- Iredale, Tom
1936. Australian molluscan notes. No. 2, Rec. Austr. Mus., vol. 19, pp. 267-340; pl. 20-24; p. 320.
- Ostergaard, Jens M.
1928. Fossil marine mollusks of Oahu. B. P. B. Mus. Bull. No. 51, pp. 1-32.
- Pilsbry, Henry A.
1920. Marine mollusks of Oahu. Proc. Acad. Nat. Sci. Phil., vol. 72, pp. 309-318.
- Ray, H. C.
1954. Mitres of Indian waters. Mem. Indian Mus., vol. XIV, no. 1, Calcutta.
- Reeve, Lovell
1844. Conchologia Iconica, pl. 5, sp. 33; pl. 20, sp. 157.
- Schröter
1788. Namen Register, p. 115.
- Suter, Henry
1913. A manual of New Zealand mollusca. Mackay, Wellington, 1120 pp., pl. 46; p. 361.

Tinker, Spencer W.

1958. Pacific seashells. Charles E. Tuttle Co., Rutland, 240 pp.; pp. 140-160.

Tryon, George W., Jr.

1882. Manual of conchology. vol. 4, p. 127, pl. 37.

Available: All Backnumbers of THE VELIGER

Because of the continued demand for complete sets of backnumbers of our journal, and because the supply of some numbers is either completely exhausted or nearly so, we have produced a second printing of the numbers in question. They are clearly marked as such by a red imprint. However, once the supply of the second printing is exhausted, it will be impossible to produce any further copies. As long as the new supply lasts we will be able to furnish complete sets of the *Veliger* at the previously announced rates, namely:

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DEPARTMENT OF LIVING INVERTEBRATES NEWLY ESTABLISHED AT THE AMERICAN MUSEUM

The American Museum of Natural History recently announced the re-establishment of the Department of Living Invertebrates. The department had been de-activated since World War II. Responsible for Recent Invertebrates, exclusive of Insects, the staff of the department includes: Dr. William K. Emerson, Chairman and Malacologist; Dr. Dorothy E. Bliss, Invertebrate Physiologist; Dr. Meredith L. Jones, specialist in Lower Invertebrates, Dr. H. E. Coomans, Research Fellow in Malacology; Frederic V. Weir and William E. Old, Jr. technical assistants; and Mrs. William Fish, secretary. Drs. Libbie H. Hyman, Horace W. Stunkard, and William J. Clench (Harvard University) are Research Associates.

The collection of mollusks at the American Museum, although of considerable historical

importance, dates from the early acquisition of the J. C. Jay collection. It was without a curator until the appointment of Dr. Emerson in 1955. At present, the collection contains more than 80,000 catalogued lots and is being rearranged by Dr. Coomans, with the able assistance of Mr. Old, according to a modern classification. The work of Dr. Coomans, who studied under Mrs. W. S. S. van der Feen-Van Benthem Jutting at the Amsterdam Museum and formerly was associated with the Caribbean Marine Biological Institute at Curaçao, is being sponsored by a grant from the National Science Foundation. Bill Old, an avid student of conchology, will handle a newly organized exchange program.

In Preparation

It is expected that on or about December 1, 1960, the Northern California Malacozoological Club will publish a supplement to volume 3 of the *Veliger*. This supplement will be devoted to the opisthobranch mollusks of the west coast of North America. The first section, by Professor and Mrs. Marcus, includes the description of 12 new species from California as well as a thorough discussion of 38 additional species from the same area. This portion of the supplement is illustrated with 199 line drawings on ten full-page plates (the format is the same as that adopted for the *Veliger* itself). The second section is a key to all known opisthobranch mollusks from Southern California to Washington. Line drawings will be used freely to clarify important diagnostic characters. A glossary pertaining to the "special language" will form a third section. Miss Joan Steinberg will be responsible for these latter two sections. An extensive and comprehensive bibliography is appended to the first and second section, respectively.

The supplement will be available to subscribers to the *Veliger* at the reduced rate of \$1.50 plus postage. Only one copy can be supplied at this price to each subscriber. Additional copies may be obtained at \$3.—plus postage, the price at which the supplement will be generally available. California residents please add 4% sales tax. Make checks payable to N. C. M. C. and mail to Mrs. Phoebe Balch, 975 Hough Avenue, Lafayette, California. (Probable mailing weight will be between 1¼ and 1½ pounds.)

A. M. U. - P. D.

1961 Convention Announced

The 1961 Convention of the A. M. U.-P. D. will be held June 28 noon through July 1 noon on the Santa Barbara Campus of the University of California at Goleta. Accommodations will be available in the Anacapa Hall, near the Marine Laboratory at the beach. Detailed information will be sent out the early part of 1961. Reserve the above dates in your date book and plan to attend. A fine program is being arranged for the meetings on this beautiful Campus.

Howard R. Hill,
Chairman

SORENSEN COLLECTION

Mr. Andrew Sorensen of Pacific Grove has given his entire collection of shells and other invertebrates to the California Academy of Sciences. This large and important world-wide collection has been transported to the Academy in Golden Gate Park, San Francisco, requiring three trips to Mr. Sorensen's home with two trucks to make the move.

Mr. Sorensen, now 97 but still active, did a great deal of collecting in the Gulf of California. His shells from the Gulf form a major and important segment of his collection which is not only of great scientific value but beautiful as well. His accounts of this collecting work appeared in the *Nautilus* from 1942-1948 and in the *Minutes of the Conchological Club of Southern California* in 1948 and 1949. In addition, he added many valuable series of specimens by purchase and exchange from Japan, Australia, and other foreign lands. He specialized in the abalones, especially the West Coast species, and his abalone collection is probably unexcelled. There are many interesting things from the Monterey Bay area taken in deep water.

According to Dr. Leo Hertlein and Allyn G. Smith of the Academy, it will be some time before Mr. Sorensen's collection can be reviewed in its entirety.

Information Desk

{We have received an inquiry relating to the technique involved in making microscope preparations of radulae for study of species relationships. This inquiry was referred to Dr. Harry K. Fritchman, who has probably made more radula preparations than any other person to whom we might have turned. Dr. Fritchman kindly sent the following answer, for which we are grateful. The Editor}

Preparation of Radulae

by

HARRY K. FRITCHMAN II

Boise Junior College
Boise, Idaho

The identification of gastropods is frequently made difficult by the erosion of the shell by sand and gravel or by fungi. In such cases identification may often be made by examination of the radula. Briefly, the radula is a feeding structure present in all Mollusca except the Pelecypoda. It is a ribbon of semitransparent material to which are affixed in a linear series the teeth and plates which support them. This organ is contained in the radula sac, an outgrowth of the oral cavity, and the arrangement of the teeth and the tooth plates is frequently distinctive for each species. The method of preparation described below has been used by me in the study of *Acmaea radulae*. It is doubtful whether it is applicable, without modification, for all radular types but it may serve as a point of departure for elaborating other techniques.

Regardless of the method of preservation, whether wet or dry, the specimen should be soaked in fresh water overnight. The method used to separate the radula from the body will depend on the size of the animal. If the specimen is less than two inches long, the entire body may be removed from the shell, placed in a vial, covered with a ten percent solution of sodium hydroxide and heated in a pan of water at a temperature just uncomfortable to the touch. If the specimen is larger, it is not economical to dissolve the entire body and the radula must be dissected out before being treated with the reagent. For a limpet an inch in length, a thirty minute treatment will dissolve the body leaving

the radula intact. The radula is then removed from the vial with a dissecting needle and transferred to a watch glass of water. *Acmaea* radulae are best studied with the teeth removed. This removal can be done in a watch glass of water by holding the end of the ribbon with forceps and gently brushing the teeth off with a fine camels hair brush. If the treatment with the hydroxide was too long or at too high a temperature, the tooth plates will also be removed, leaving little for study except the bare ribbon.

After rinsing in clean water, the ribbon may be stained in aceto-carmine which is prepared by boiling a small amount of powdered carmine in 40% acetic acid until a saturated solution is obtained. After cooling it is filtered and is then ready for use. *Acmaea* radulae stain in thirty seconds to one minute and are then transferred to 70% ethyl alcohol for a minute and then to 95% alcohol. A microscopic slide and cover slip are prepared by cleaning them in alcohol, drying them and placing a drop of Euparal in the center of the slide. The ribbon is then placed in the Euparal, care being taken that the toothed side is up. Some skill is required to prevent twisting and kinking. More Euparal is added if needed and the cover slip is carefully lowered into position. The slide may be examined immediately under a microscope but it must be kept horizontal for a few hours until the Euparal has hardened. The slide is labeled with the information as the shell from which it came. If a large number of radulae are to be prepared at one time, they can be identified by dropping into each vial a small label cut from an index card and bearing an identifying number in India Ink.

A few additional suggestions are in order. The most useful size of cover slip is the square 22 mm. of no. 2 thickness. Long radulae may be cut into several sections and mounted side by side. Natural yellow Euparal is the mounting medium of choice since it is miscible with ethyl alcohol and does not require that the material to be mounted be completely dehydrated. If piccolyte or Canada balsam is used, complete dehydration is necessary in 100% alcohol, which in turn must be removed in xylol or tuluol before mounting. (All of the mentioned reagents can be obtained from any large biological supply house.)

Some difficulties to be expected from some non-*Acmaea* radulae will be low stainability, non-removable teeth and a tendency for the sides of the ribbon to roll under. Perhaps fur-

ther work will solve these problems. Finally, it should be mentioned that to compare radulae accurately, the same regions of the ribbons should be examined, regions where the teeth are fully developed and yet not abraded by wear. The smallest radula I have prepared was from an *Acmaea rosacea* Carpenter one-eighth of an inch long. Such work may require a dissecting microscope for manipulating during the de-toothing process if that is done.

Books-Periodicals-Pamphlets

SEASHORE LIFE OF JAPAN

by Kikutaro Baba

Hokuryukan, Tokyo, Japan. Pp. 148 +
10, 4 colored plates. 1958. 500 yen
(about \$1.50).

Even though the captions of this book are almost entirely in Japanese, one can find much of interest in it. A few place names are in Roman type, and Latin names are given for the marine organisms. Even the photographs on the cover are identified on an explanatory page at the front of the book. Following this page is a map showing the locations of all the Japanese marine biological laboratories, with colored arrows to indicate the flow of the oceanic currents. Unfortunately, the map captions are in Japanese and were made understandable to this reviewer by a hand-traced overlay that the author had included in a gift copy. Four colored plates follow the map, with pictures that are repeated elsewhere in the book in black-and-white. The main part of the book consists of photographs of the settings of selected marine biological laboratories, with an array of pictures of the organisms — mostly the invertebrates — characteristic to the area, beginning with Akkeshi, on Hokkaido Island, in the north, and ending with Amakusa Laboratory and the Tokara groups of islands in southern Kyushu. Life histories for many kinds of marine animals are shown, from egg to larval stages, with some unusually fine microphotographs. Dr. Baba's long interest in opisthobranchs is reflected, as one might expect, in his emphasis on this colorful and bizarre group. Many of the pictures show the snails crawling about in their natural surroundings. Eloquent testimony to the hours of patient search that went into this work is the number of pictures of egg-masses

of these mollusks. That the author is a serious photographer can be surmised by his inclusion of technical data on exposure time, etc., in all captions. We catch a glimpse of him at work in a picture on the page following the index, where he is shown aiming his camera at a small subject on a rock.

Although this book deals primarily with the intertidal marine fauna of Japan, it has a much wider interest, for many of the species range southward to the East Indies and many of the genera are recognizable to Californians. To leaf through the book and to study the pictures carefully is a good substitute for actually going collecting, and in these well-composed and well-reproduced pictures one has the privilege of viewing the seashore through the eyes of a trained biologist.

A. Myra Keen

VENUS:

JAPANESE JOURNAL OF MALACOLOGY

Vol. 20, No. 4, for November, 1959.

"Descriptions of new species of marine shells from Japan", T. Kuroda. [Two new genera of uncertain relationship; two new species of Mitridae; three of Latiaxis, two of Anistrosyrinx.]

"Another new species of Assimineae, a trematode's intermediate host snail from Japan", T. Kuroda.

"Descriptions on Siphonalia trochulus tokaiensis, n. subsp. and Mitra hayashii, n. sp.", T. Kira.

"On Latiaxis filiaregis, n. sp.", K. Kurohara.

"Description of a new species of Pleistocene Turridae, Micantapex oyamai, n. sp.", T. Makino and S. Ogose.

"On the differentiation of the crenated-fold in the midgut-gland of Eulamellibranchia. III. Various developmental stages of Meretrix lusoria", M. Nakazima.

"Review of nomenclature on Japanese shells (3)", K. Oyama.

JOURNAL DE CONCHYLIOLOGIE

Vol. 100, No. 1, for January 31, 1960

(received in June, 1960)

"Les collections malacologiques publiques, leurs problèmes et possibilités pour une coopération internationale", L. Forcart.

"Nouvelles: Fondation d'une union malacologique européenne".

PROCEEDINGS OF THE MALACOLOGICAL SOCIETY OF LONDON

Vol. 34, Part 1, for April, 1960

"Petalifera habei, a new species from Japan", N. B. Eales.

"A new species of Stephopoma (Siliquariidae: Mesogastropoda) from the eastern Atlantic Ocean", J. E. Morton and A. M. Keen (includes discussion and figure of a species of Stephopoma from the Panamic province).

GEOLOGY AND PALEONTOLOGY OF THE MARINE PLIOCENE OF SAN DIEGO, CALIFORNIA. PART 2a. PALEONTOLOGY (COELENTERATA, BRYOZOA, BRACHIOPODA, ECHINODERMATA)

by L. G. Hertlein and U. S. Grant, IV
San Diego Soc. Nat. Hist., Mem., vol. 2, part 2a, pp. 73-133, pls. 17-26.
1960.

The first part of a monograph concerning Pliocene fossils from the San Diego area deals with several groups of marine invertebrates which occur with the rich and important molluskan faunas which will be treated in subsequent parts. Bryozoans are listed and discussed generally. Recognized species and subspecies of corals (5), brachiopods (6), and echinoderms (18) are carefully described, discussed, and illustrated.

A NEW LOCALITY OF THE VICARYA FAUNA FROM AOMORI PREFECTURE

by Takehiko Iwai
Paleont. Soc. Japan, Trans. Proc., n. s., no. 37, pp. 201-208, pl. 24, 1960.

An early Miocene tropical or subtropical molluskan fauna is reported from central Japan. Thirteen species, none of them new, are identified. Species of Anadara (3), Pitar (3), and Vicarya (1) are illustrated and discussed.

NUOVE OSSERVAZIONI SULLA FAUNA A MOLLUSCHI DI M. POSTALE

by R. Malaroda
Riv. Italiana Paleont. Strat., vol. 66, pp. 213-236, pl. 23-28, 1960.

The author's earlier (1954) work on the large Eocene (Lutetian) molluskan fauna of Mount Postale, Venetia, is amended with the illustration and discussion of eight pelecypod species and 12 gastropod species. None of the species are new.

DIE GASTROPODEN DES JÜNGEREN
TERTIÄRS IN NORDWESTDEUTSCHLAND.
TEIL 2:

PROSOBRANCHIA MESOGASTROPODA:
1. LITTORINACEA, RISSOACEA,
CERITHIACEA

by Hans-Joachim Anderson
Meyniana, vol. 9, pp. 13-79, pl. 1-12,
1960.

Sixty-four late Oligocene and Miocene species of the superfamilies Littorinacea, Rissoacea, and Cerithiacea from northwestern Germany, some of them extant species, are systematically discussed and figured with large pen and ink drawings. One genus, *Goergesia* (Rissoacea, Pyrgulinae) is described as new with the type species *Rissoa terebellum* Philippi. Five species described as new are: *Lacuna* (*Pseudocirsope*) *teichmüller*, L. (P.) *dittmeri*, *Putilla* (*Ovirissoa*) *gliberti*, *Alvania* (*Alvinia*) *pseudopartschi*, and *Alvania* (*Alvania*) *holsatica*.

DIE GASTROPODEN DES JÜNGEREN
TERTIÄRS IN NORDWESTDEUTSCHLAND.
TEIL 2:

PROSOBRANCHIA MESOGASTROPODA:
2. REVISION DER NATICACEA

by Hans-Joachim Anderson
Meyniana, vol. 9, pp. 80-97, pl. 1-4,
1960.

Nineteen species, none of them new, of the superfamily Naticacea from late Tertiary rocks of northwestern Germany are discussed and illustrated by pen and ink drawings.

TWO NEW GENERA OF LAND MOLLUSKS
(PAPUINIDAE) FROM THE CENTRAL
HIGHLANDS OF NEW GUINEA

by W. J. Clench and R. D. Turner
Jour. Malac. Soc. Australia, no. 3, pp.
4-9, pl. 1, text fig., November 13, 1959.

Describes *Wahgia* n. g., with *W. juliae* n. sp., as type species and *Papuanella* n. g., with *Geotrochus ogeramuensis* (Kobelt) as type species. Good illustrations.

BIOLOGIST COLLECTS SHELLS

by Gilbert L. Voss (Marine Lab. Univ. Miami)
Sea Frontiers (published by Intl. Oceanographic Foundation), vol. 6, no. 2, pp.
67-77, May, 1960.

Illustrated. A nontechnical article on shell collecting with some useful information on equipment used and the preparation and preservation of specimens.

CATALOGUE AND ILLUSTRATIONS
OF MOLLUSKS DESCRIBED BY
WESLEY NEWCOMB

with a bibliographical resumé
by Arthur H. Clarke, Jr.
Bull. American Paleon., vol. 41, no.
188, pp. 135-160, pl. 17. 1960.

An annotated list of 126 mollusks described by Wesley Newcomb during the years 1835-1874 is presented with illustrations of a few species not previously figured.

CATALOGUE OF THE TYPE AND FIGURED
SPECIMENS IN THE PALEONTOLOGICAL
RESEARCH INSTITUTION

by Doris C. Brann and Lois S. Kent
Bull. American Paleon., vol. 40, no.
184, pp. 1-995, pl. 1. 1960.

10,904 specimens are listed alphabetically by generic and trivial names together with references to publications where they were described or figured. A description is provided for a *nomen nudum* of Harris, 1919, from the Eocene of Louisiana and Mississippi which becomes *Crassatella clarkensis* subsp. *ludoviciana* Kent. The new name, *Murex sabinola* Palmer, is provided for *Murex veatchi* Palmer, 1937, from the Eocene of Texas and Louisiana.

CARDIIDS FROM THE MIYAZAKI GROUP
by Tsugio Shuto

Palaeont. Soc. Japan, Trans.
Proc., n. s., no. 37, pp. 209-222,
pl. 25, text fig. 1, 1960.

Seven Miocene species of the family Cardiidae from southern Japan are illustrated and described and their relationships discussed in detail. The following new species are recognized: *Vepricardium kyushuense*, *Vasticardium hyuganum*, *Clinocardium subdecussatum*, and *Laevicardium pigmae*.

PALEONTOLOGY AND CORRELATION
OF THE OHLSON RANCH FORMATION

by Joseph H. Peck
Univ. Calif. Publ. Geol. Sci.,
vol. 36, pp. 233-242, pl. 21, 1960.

Two faunas consisting of 31 pelecypod species, 10 gastropod species and three brachiopod species, are listed from 24 northern California localities. Both faunas are believed to represent the Pliocene of the West Coast of North America and are correlated with faunas of the upper type Purisima formation and the lowermost Merced formation.

THE MORPHOLOGY OF PHYLLAPLYSIA
ZOSTERICOLA, NEW SPECIES

by James E. McCauley, Oregon State College
Proc. Calif. Acad. Sci., 4th ser., vol.
29, no. 16, pp. 549-576, 6 figs. May
9, 1960.

A full account of this green, striped tecti-branch species from the Puget Sound area formerly misidentified as P. taylori Dall, a species now correctly known as Petalifera (Petalifera) taylori (Dall). Type in the California Academy of Sciences, no. 8,342, Paleo. Type coll.

MAGNESIUM, STRONTIUM, AND ARAGONITE
IN THE SHELLS OF CERTAIN LITTORAL
GASTROPODS

by David Krinsley
J. Paleon., vol. 34, no. 4, pp. 744-755,
text figs. 1-2, 1960.

A comparison of magnesium, strontium, and aragonite percentages in shells of living and fossil specimens of Tegula funebris (A. Adams), Fissurella volcano Reeve, and Olivella biplicata (Sowerby) reveals that strontium and apparently aragonite have remained unchanged while magnesium has been mobile since the fossil shells were deposited.

DISTRIBUTION OF THE FRESHWATER CLAM
PISIDIUM ULTRAMONTANUM
A ZOOGEOGRAPHIC INQUIRY

by Dwight W. Taylor
American Jour. Sci. Bradley Vol., vol.
258-A, pp. 325-334, pl. 1, text figs. 1,
2 (distribution maps). 1960.

A discussion of the faunal ties between distributions of Recent and fossil assemblages of this small finger-nail clam now found living only in northeastern California and south-central Oregon.

CLAMS, SQUIDS, AND OTHER MOLLUSKS
by Virginia Orr (Acad. Nat. Sci. Philadelphia)

Footes Printes (House publ. of Footes
Mineral Co., 18 West Chelton Avenue,
Philadelphia, Pa., John W. Donahey,
ed.), vol. 31, no. 2, pp. 3-11, 1960.

Beautifully illustrated with photos by Miss Orr, including front and back cover of Conus and Murex in color. An excellent nontechnical article on the science of malacology with many interesting facts about mollusks.

MATAJIRO YOKOYAMA'S TERTIARY
FOSSILS FROM VARIOUS LOCALITIES
IN JAPAN

by Jirô Makiyama
Paleon. Soc. Japan, Spec. Papers no.
5, pp. 1-4, pl. 58-86. 1959.

Tertiary mollusks described by Matajiro Yokoyama in papers published during the period 1927-1930 are illustrated and placed in a modern taxonomic perspective.

THE STATUS OF SYSTEMATIC WORK
IN THE TERIDINIDAE

by Ruth D. Turner
Repr. from Marine boring and fouling
organisms, Dixy Lee Ray, ed., Friday
Harbor Symposia, Univ. Washington
Press, Seattle, pp. 124-136, 1959.
Review of work done and in progress on systematizing names of wood-boring mollusks.

ZWANZIG NEUE LANDSCHNECKEN AUS PERU
by Wolfgang K. Wyrach

Archiv für Molluskenkunde (Frankfurt
am Main), vol. 89, no. 1/3, June 30,
1960, pp. 49-55, pls. 3-6. Lima.

Describes 20 new species or subspecies of Peruina, Euglandina, Zilchistrophia (n. gen.), Systrophia, Thaumastus, Bostryx, Naesiotus, Scutalus, and Epiphragmophora. Beautifully illustrated.

ZUR KENNTNIS VON NEWBOLDIUS
(BULIMULIDAE)

by Wolfgang K. Wyrach
Archiv für Molluskenkunde (Frankfurt
am Main), vol. 89, no. 1/3, June 30,
1960, pls. 7-8. Lima.

An account of this Pilsbry genus. One new species described from central Peru and the Eastern Andes.

The Geological Society of America, 419 West 117th Street, New York City, New York, announces the publication on August 10 of the Treatise on Invertebrate Paleontology, Part I: Mollusca I (Chitons, Scaphopods, Gastropods), by Brookes Knight, et al. 351 pages, 216 figures. \$7.50.

THE VELIGER is open to original papers pertaining to any problem concerned with mollusks from the Pacific Region.

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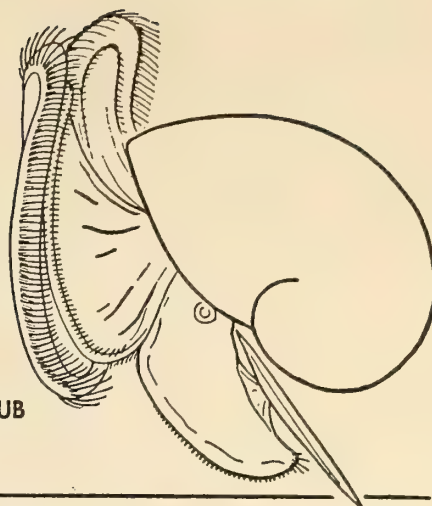
Short articles containing descriptions of new species or lesser taxa will be given preferential treatment in the speed of publication provided that arrangements have been made by the author for depositing the holotype with a recognized public Museum. Museum numbers of the type specimens must be included in the manuscript. Type localities must be defined as accurately as possible, with geographical longitudes and latitudes added.

Short original papers, not exceeding 500 words, will be published in the column "NOTES & NEWS"; in this column will also appear notices of meetings of the American Malacological Union, as well as news items which are deemed of interest to our subscribers in general. Articles on "METHODS & TECHNIQUES" will be considered for publication in another column, provided that the information is complete and techniques and methods are capable of duplication by anyone carefully following the description given. Such articles should be mainly original and deal with collecting, preparing, maintaining, studying, photographing, etc., of mollusks or other invertebrates. A third column, entitled "INFORMATION DESK," will contain articles dealing with any problem pertaining to collecting, identifying, etc., in short, problems encountered by our readers. In contrast to other contributions, articles in this column do not necessarily contain new and original materials. Questions to the editor, which can be answered in this column, are invited. The column "BOOKS, PERIODICALS, PAMPHLETS" will attempt to bring reviews of new publications to the attention of our readers. Also, new timely articles may be listed by title only, if this is deemed expedient.

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A Study of the Reproductive Cycle in the California Acmaeidae (Gastropoda)

Part I

by

HARRY K. FRITCHMAN II

(From the Department of Zoology, University of California, Berkeley, California,
and the Department of Biology, Boise Junior College, Boise, Idaho)

(Plate 10)

INTRODUCTION

The limpets of the genus Acmaea Eschscholtz, 1833, are one of the most common gastropod types to be found in the rocky intertidal zone of the Pacific Coast of the United States. They are conspicuous not only because of the large number of individuals which are present but also because of the numerous species encountered. These various species and subspecies, of which 21 are known within the boundaries of California, have occupied practically every ecologic niche available to them in the rocky intertidal zone. The requirements of such a niche seem to be essentially three in number: a fairly rigid substrate for attachment of the broad foot, a source of vegetable food and at least some contact periodically with sea water. Wherever these conditions are met, there will usually be found a species of Acmaea which has become adapted to the niche. These niches may be quite unspecific and several eurytopic species may inhabit what seems to be the same type of habitat. By contrast, there are several very stenotopic species which are restricted to specific algae or other very special locations. It is evident that an extensive radiation has taken place in this genus, allowing its species to colonize to a remarkable degree this rocky intertidal zone. It is the intent of this work to elucidate the reproductive mechanisms and cycles of the several species of this genus and, in so doing, to suggest what the nature of these speciation processes might have been.

The Acmaeidae are a relatively primitive family of aspidobranch gastropods, containing only three genera in addition to Acmaea. All of the members of the genus Acmaea are superficially bilaterally symmetrical animals bearing a cap-like shell. Internally however, they exhibit to a high degree the effects of torsion.

The anatomy of A. fragilis has been described by Willcox (1898), and some of the salient features of the genus are noted in the following. A single bipectinate ctenidium is present, the post-torsional left, which projects diagonally forward and across the mantle cavity. The anus opens into the right side of the mantle cavity and is flanked on each side by the apertures of the renal organs. As in all aspidobranchs, the post-torsional right kidney has been greatly developed while the left has become much reduced. The right post-torsional gonad is the functional gonad, a feature common to all gastropods. The latter organ opens into the distal end of the right kidney and the genital products are thus discharged via the right renal aperture. There has been some disagreement in the literature concerning the actual method of shedding the gametes. Willcox (op. cit.) postulates that the right renal papilla containing the renal aperture may serve as a copulatory organ in males, thus permitting internal fertilization. Indeed, she describes (Willcox, 1905) what might be interpreted as a mating procedure between a pair of A. testudinalis. Thorson (1935) found that A. rubella contained larvae in the mantle cavity. These are the only descriptions in the literature which support the idea of internal fertilization. All other evidence is to the contrary and indicates that external fertilization is the rule, if not the only method employed by the Acmaeidae (Boutan 1898, Hewatt 1938, Thiele 1931). My observations certainly support this conclusion since, of the 11 species which have been investigated in this study, 10 have been known to spawn in the laboratory, the eggs and sperm being released freely into the water. Thus, barring the effects of proximity due either to active aggregation or simply to dense populations, fertilization of the eggs takes place at random in the sea water.

The only recent definitive work on Acmaea is a revision of the genus written in 1937 by Avery Ransom Grant as a doctoral thesis at the University of California. In addition to the taxonomy of the group, this extensive and unpublished paper includes much information on the distribution and ecology of the numerous species of this genus.

During her earlier studies of the ecology of the California forms, Test (1945) became much interested in the question of speciation in the genus and, while not entirely rejecting the isolating effects of geographical barriers, she subscribed very strongly to the concept of ecologic or sympatric speciation (Test, 1946). Briefly, it was her belief that a single eurytopic species, through the process of mutation, gave rise to extreme variants which were able to colonize habitats within the rocky intertidal zone which were not available to the parental species. These changes could be either morphological, being reflected in modifications of the shell for fitting specific substrates (e.g., algal stipes), or physiological, which would allow the animal to withstand greater extremes of temperature and desiccation encountered in higher intertidal zones. To these could be added also the behavioristic changes such as preferences for smooth versus rough rock substrates and nocturnal instead of diurnal activity patterns. Test then postulated that the genetic integrity of these mutant populations would be maintained by either close or internal fertilization and thus a reproductive barrier would be created between the new and the parental populations. Because of anatomical restrictions, internal fertilization is known to be impossible and because close fertilization is possible only in dense populations (and improbable in the cases of some very stenotopic species) some other mechanism must have been operating to establish the reproductive barrier

have been operating to establish the reproductive barrier required by the concept of sympatric speciation. It was felt that if, under the impress of new environmental factors, the reproductive cycle of the variant population could be so altered that it no longer coincided with that of the parental group, the necessary genetic isolation could be achieved. A cyclic isolation was then to be sought for between presumed parental and offshoot species, a cyclic difference which could be correlated with the differences in the ecology of the species concerned.

Species List

The genus Acmaea, as revised by Grant (1937),

includes five subgenera based on the characteristics of the radular ribbon from which the teeth have been removed. For details on this procedure see Fritchman (1960). Of these five subgenera, three are known to occur on the coast of California.

The subgenus which she considers to be the most primitive is the subgenus Acmaea Dall, 1871, whose type species is A. mitra Eschscholtz, 1833. This group has a radula which lacks the lateral hooks or uncini and which possesses basal bodies of simple pattern which fit closely together. Only three of the California species are referable to this subgenus: A. mitra, the type species, A. funiculata (Carpenter, 1864), and A. depicta (Hinds, 1842), a stenotopic form restricted to the eelgrasses Zostera and Phyllospadix.

The type species of the second subgenus, Notoacmaea (Iredale, 1915), is Acmaea pileopsis, a species not occurring on the West Coast of North America. The radula of the members of this subgenus has a more complicated basal body structure but lacks uncini. The plates are characterized by several protruding processes which prevent the basal bodies from fitting well together. California species referable to this group include the following: A. scutum Eschscholtz, 1833, A. fenestrata fenestrata (Reeve, 1855), A. fenestrata cribraria Carpenter, 1857, A. persona Eschscholtz, 1833, A. insessa (Hinds, 1842), and A. paleacea Gould, 1851.

The third subgenus found in California is Colisella Dall, 1871. All members of this group possess a radula each of whose plates bears a pair of uncini on the lateral margins. The following species are placed in this group: Acmaea pelta Eschscholtz, 1833, the type species of the subgenus, A. asmi (Middendorf, 1847), A. scabra (Gould, 1846), A. ochracea Dall, 1871, A. instabilis (Gould, 1846), A. digitalis Eschscholtz, 1833, A. limatula Carpenter, 1864, A. limatula morchii Dall, 1878, A. triangularis (Carpenter, 1864), A. conus Grant, 1945, and A. paradigitalis Fritchman, 1960.

One other species which occurs in California, Acmaea rosacea Carpenter, 1864, is included by Test as a species inquirendae. On the basis of the radular characters it should probably be assigned to the subgenus Notoacmaea.

Because of their geographical distribution, some of these species and races could not be studied since the collecting areas were restricted to the region of San Francisco. For this reason, the following were not investigated: Acmaea conus, A. f. fenestrata, A. limatula, and A. depicta, all of which are found only south of the Monterey Peninsula. Another group of spe-

cies was not investigated, either because of their relative scarcity in the local intertidal zone or their occurrence subtidally. This group included A. rosacea, A. triangularis, A. funiculata, and except for a few short studies, A. instabilis and A. ochracea. A. paradigitalis was undescribed at the time of the study. The remaining eleven species were studied for periods ranging from seven months to somewhat more than three years.

Collecting Areas

Four areas in the vicinity of San Francisco were regularly visited to procure the samples of limpets used in the investigation. Three of these lie to the south of San Francisco in San Mateo County and are located on the open coast.

The first of these is the locality known as Rockaway Beach. This beach is terminated at its southern end by a rocky point (37°30'25" N; 122°30' W) at the tip of which is a partially destroyed concrete breakwater. This structure and the south-facing portion of the point were the sites of extensive collections.

The second area is Moss Beach (37°31'30" N; 122°31' W), a locale composed primarily of hard sandstone reefs of rather uniform height which extend for about 100 yards seaward from the sand beach.

Pigeon Point (37°12'20" N; 122°24' W), the southernmost of the three areas, is a rocky point upon which a lighthouse has been constructed. The collecting area to the north of the building consists of massive sandstone with imbedded boulders arising from a bottom of gravel and sand. Coralline algae are plentiful and Acmaea mitra, which uses this for food, is thus relatively abundant here.

The single northern area utilized as a collecting site was the village of Marshalls, Marin County (38°09'45" N; 122°53'30" W) on the east shore of Tomales Bay. This is a shallow inlet, very long and narrow, the long axis running northwest to southeast. Since its mouth is constricted and the bay is protected by the peninsula which forms its western shore, heavy surf is lacking inside the bay. The water temperature is somewhat higher than that of the open ocean and the salinity may also be altered. Its beaches are mostly of gravel and mud and heavy growths of the familiar open coast algae are absent. It is here that Acmaea limatula morchii was obtained.

The method here adopted for designating intertidal heights is that set forth by Ricketts and

Calvin (1952). This system divides the intertidal zone into four subzones, the highest being zone one, the lowest, zone four. Zone one extends from the level of standard mean high water, +5.0 feet, upwards to the limits of the beach. It is an area of dry rocks, little algae, and inhabited by only a few hardy animals. It is frequently referred to as the splash zone. Zone two extends from a height of +5.0 feet down to +2.5 feet, the level of mean higher low water, while zone three lies between the latter figure and the 0.0 tide line. Zone four is that area extending from 0.0 level downwards to the line of lowest low tide, about -1.5 feet. This area is uncovered for only a few hours during the month and is populated by animals and plants which are very sensitive to heating and desiccation.

Method of Examination

Of the three commonly used methods for determining the reproductive seasons of marine animals, two had to be discarded as being non-feasible for this study. These two were the plankton analysis method for Acmaea larvae and the determination of spawning time by watching for settling larvae. The plankton analysis method, while of great applicability when masses of sessile, sub-littoral forms such as the oyster are being studied, is of little use here because it is impossible to distinguish between larvae of different species. This fact also militates against searching for newly settled and metamorphosed larvae, which method would be, in addition, very time consuming.

It thus became necessary to adopt a third procedure, that of periodic examination of samples of adult limpets collected from specific areas of the intertidal zone. The practice of collecting samples of the limpets at intervals of two weeks was initiated at the outset of the study. The dates of collection were chosen for the most favorable tidal conditions insofar as the daylight hours permitted. The coincidence of low tides with early morning hours in summer and with late afternoon hours in the winter months often made collections of very low intertidal forms difficult or impossible. In addition, the series of poor collecting tides during the spring and fall solstices often prevented these low intertidal collections. Occasionally a heavy surf would also intervene, and collecting would have to be restricted to the high and middle intertidal forms. Thus some gaps appear in the data which are the results of factors beyond our control. It must be admitted that while

this method was quite adequate for establishing the yearly cycles of the several species, it is not adequate for determining the exact time of spawning by any one of the populations under study because of the fourteen-day interval between collections. In the cases of those species which live in the lower zones, i.e., three and four, collections could be made only on the lowest tides of the month. Here the method of study is limited by the natural tidal fluctuations which follow a fourteen-day cycle. However, those animals living at levels of +2.5 feet or higher could be collected almost daily, conditions of wind and surf permitting. Several factors made this procedure impractical. The nearest collecting areas are about thirty miles distant from the University and the time and expense involved in making the trip daily became enormous. The problem of storage in the laboratory had to be considered as well as the time available for examination of the specimens. For these reasons, then, the system of collecting as described above was decided upon as being the most suitable compromise.

The limpets were removed from their positions in the rocky intertidal, placed in pint collecting jars with sea water and returned to the laboratory. No effort was made to refrigerate the samples during the collecting trips. In the laboratory, the animals in their jars were placed in a refrigerator which was maintained at 11°C. and which was equipped with air outlets which permitted the jars of water to be aerated constantly. The jars were removed at intervals of two days, the water poured off, and the animals allowed temporarily to dry off and to reach room temperature for one to two hours. Fresh filtered sea water at room temperature was then added to the jars and the limpets returned to the refrigerator. The procedure was continued until time was available to examine the animals and to determine their reproductive condition.

The procedure for examination was as follows. The animal was removed from its shell by cutting the horseshoe-shaped shell muscle at its attachment to the shell. The entire visceral mass of the limpet is thus exposed, with the digestive gland uppermost. In *Acmaea* the single gonad lies between the dorsal surface of the foot and ventral surface of the digestive gland. It extends from the extreme posterior end of the animal anteriorly to the radula sac and sends dorsally a branch from the left side towards the right where it opens into the mantle cavity via the right kidney pore just to the right of the a-

nus. When the animal is in a ripe condition, the gonad can be seen lying between the foot and the digestive gland. The animal is held in such a way that a dissecting needle can be inserted at the junction of the mantle with the posterior dorsal margin of the foot. The needle is then worked to the right and left around the foot, freeing the foot from the visceral mass while leaving the foot attached to the body anteriorly. The foot is flexed so that the ventral surface of the gonad can be examined under a dissecting microscope.

Since the individual animals varied considerably in size, the size of the gonad varied accordingly. Thus, absolute size of the gonad could not be taken as a criterion of reproductive condition when dealing with a sample of a species which showed great size variation. *Acmaea asmi* is an exception to this, since its size is not subject to much variation because of limitations placed upon this by its habitat upon *Tegula funebris*. For this reason, the measurement of gonad thickness was used as a guide to the reproductive condition of the animals of this species. This measurement was made from the lateral view and included the distance from the ventral surface of the gonad to the loop of the intestine which marks the ventral extent of the digestive gland and the dorsal margin of the gonad. A small hand-scale graduated in millimeters was used for this purpose.

In the absence of any good quantitative measurements, a series of rather subjective terms was used to classify the various gonad conditions. The three conditions which are most readily determined are those classified as "ripe", "spawned", and "indeterminate". These terms are explained below.

In all ripe animals, both male and female, the most characteristic condition is that of extreme turgor of the gonad. When the mantle membranes are ruptured in such an animal, the gonad in its membrane bulges forth through the opening and, indeed, often ruptures so that the genital products themselves are exposed. This extreme turgor is readily recognized and serves as the best single characteristic of a ripe animal. In addition, the eggs of the female are seen to be in very tight clusters, so tight that the individual eggs are deformed from their normal spherical shape. The follicles of the male testis are completely filled with the white spermatic fluid and are uniformly opaque.

The spawned gonad of both sexes is characterized by being completely flaccid, the membrane of the emptied gonad having not recover-

ed from the extreme distension of the ripe condition. In the female, a few residual eggs remain scattered loosely throughout the nearly empty sac and, in addition, a moderate quantity of granular material, probably young eggs, is present. The testis typically has on its surface a broad dark brown net which previously delimited the individual follicles. These may be almost empty and contain only small white or gray traces of spermatic fluid.

Animals in the indeterminate condition cannot be identified sexually. No traces of eggs or spermatic fluid are present and only microscopic examination of sections of the gonad would permit one to classify the animal as to its sex. This condition often follows the spawned condition in those limpets which spawn only once a year.

The two following conditions of the gonad are even more subjective in interpretation than the three mentioned above and are accordingly of less value.

An animal which is considered to be "partially ripe" is one whose gonad is being redeveloped from a previously spawned condition based on observations of the population under study. Typically, this term is applied as soon as the flaccid condition of the gonad disappears and it begins to fill with new gametes. It is used until the gonad assumes the extreme turgor of ripeness. In the female, the eggs are initially small and in loose clusters, gradually taking on the appearance described for the ripe ovary. The follicles of the testis slowly accumulate streaks of spermatic fluid in their centers and the follicles remain rather translucent until the testis is almost ripe.

In those populations where complete evacuation of the gonad contents does not occur at spawning, the gonad passes into a condition here referred to as "partially spawned". Obviously this state can be detected only when the previous sample was known to be ripe or almost so. The conversion from a ripe condition to one of partially spawned involves primarily a loss of the extreme turgor in both sexes. The eggs are large but in loose clusters or without arrangement. The follicles of the testis are clearly only partially filled with fluid.

Environmental Factors Analysed and Sources

Ocean water temperatures are those recorded by the U. S. Coast and Geodetic Survey at Fort Point, Presidio of San Francisco. These observations are made daily between 0700 and 0900 at the surface of the water.

Tidal heights are those of the Golden Gate, San Francisco, recorded by the U. S. Coast and Geodetic Survey. Although a correction factor of -0.2 feet should be applied to the open coast area of Princeton, Half Moon Bay, such corrections have not been made in this study.

Lunar cycles have been taken from the World Almanac.

The general yearly trends of these and other environmental factors may be outlined as follows.

Air temperature. The lowest mean monthly temperature is that of January from which level it rises steadily until June in monthly increments of two to three degrees Fahrenheit. From June until the maximum is reached in September there is a decline in the rate of temperature increase, the total rise during this period being only about two degrees. Beginning with October, there follows a rapid decrease in mean monthly temperature of about five degrees per month until the minimum of January is again reached. January and October are thus months characterized by reversals in the direction of temperature change.

Surface water temperatures. The mean surface water temperatures parallel closely those of the mean air temperatures. During the period of May through September, the air temperature means exceed that of the water, while the reverse is true during the other seven months.

Table 1

	Mean Monthly Air Temperature and Precipitation at San Francisco (source: World Almanac)		Mean Monthly Surface Water Temperature at Fort Point: 1922 - 1947 *)
	Temp. Degrees F	Precipit. (inches)	Temp. Degrees F
January	48	3.5	51
February	50	3.4	52
March	53	2.9	53.6
April	54	1.2	54.7
May	57	0.4	55.9
June	60	0.1	57.6
July	61	0.0	59.1
August	61	0.0	59.8
September	62	0.1	60.4
October	59	0.7	59.3
November	54	1.4	55.9
December	49	3.7	52.8

*) source: U. S. Coast and Geodetic Survey

January and October again are critical months.

Precipitation. The rainy periods are restricted, in the main, to the first five and the last three months of the year. The period of June through September has very little or no rain. These data are summarized in Table 1.

Spawning Patterns

Subgenus Acmaea

Acmaea mitra Eschscholtz, 1833

The ecology of this stenotopic species is interesting and quite distinctive. It is found exclusively on rocky substrata which are covered with the encrusting coralline algae Lithothamnion and Lithophyllum. These algae are common to lower zone three and zone four and are restricted not so much by their temperature requirements as by their need for almost continuous submergence judging from the fact that they are frequently found in permanent tide pools in zones two and three. Acmaea mitra is less tolerant of warm water and is found in greatest abundance at and below the zero tide level. The restriction of A. mitra to this type of substratum is based on the animals' utilization of coralline algae for food. The fecal pellets of the limpet are perfectly white calcareous strings composed of particles rasped from the plant. Occasionally a limpet of this species will be found on a rock in zone three which is not coralline encrusted. Such an abnormal position may be explained by the animal's having been torn loose from its usual position and cast upwards by the sea. Since such an animal does not void any fecal pellets, it is assumed that it is not feeding and will eventually starve to death.

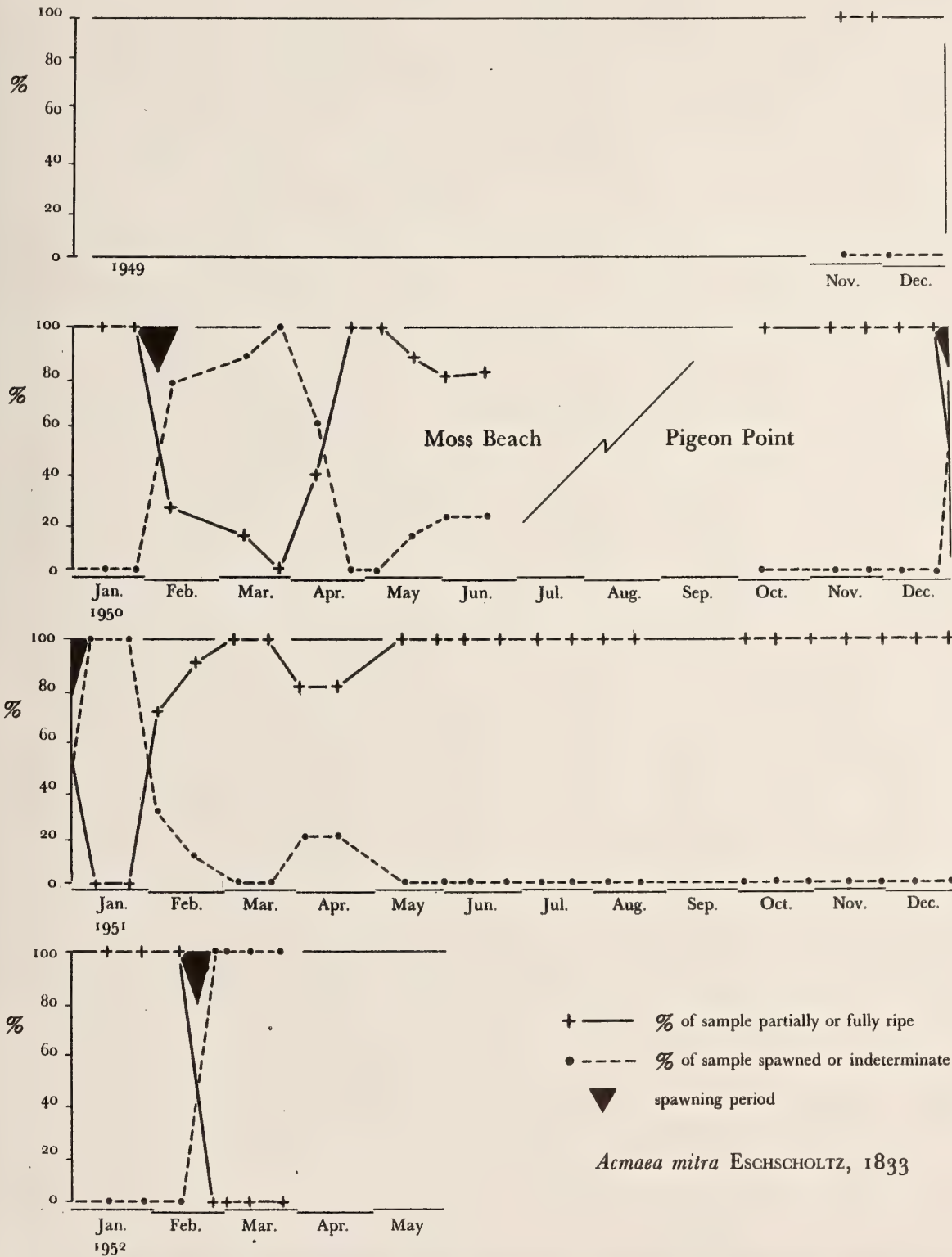
The majority of the living material studied was taken from two areas: Moss Beach and Pigeon Point. Since this species has a very simple and clearcut reproductive cycle, it was possible to use only a few animals per collection and still obtain an accurate representation of the entire yearly cycle. This was fortunate, since at neither of the collecting sites are the animals abundant and heavy collections would soon completely destroy the populations. Typically, then, five animals were taken for examination at two-week intervals, the period of study extending from November, 1949, to the last of March, 1952. A total of 78 animals was taken from Moss Beach between November 19,

1949, and June 18, 1950. This total included 34 males, 28 females, and 16 indeterminate. Between October 14, 1950, and March 31, 1952, 221 animals were taken from Pigeon Point; 117 males, 100 females, and 4 indeterminate. Thus, in all, 299 limpets of this species were examined.

The annual nature of the reproductive cycle of this species at this latitude has been clearly established (Plate 10). It spawns in the localities under study once a year in the winter months. The approximate time of spawning is readily determined since the gonads of the animals have been in a state of extreme turgor for several months prior to the event, and the sudden appearance of spawned gonads is a striking change admitting of no misinterpretation. Another characteristic is a long and gradual build-up of the gonad which begins very soon after spawning has occurred. This redevelopment may begin either from an indeterminate or from a spawned gonad.

The spawning of the Moss Beach population was recorded in February and March of 1950. Although the major spawning took place between January 29 and February 12, it was not until March 28 that no unspawned animals were found, the total time elapsing between the onset and the completion of spawning being two months. By April 23 all of the animals in the samples were redeveloping the gonads, the small eggs being clearly visible in the ovary arranged in long sinuous rows. The decline of the percentage of ripe or partially ripe animals in May and June, 1950, does not represent a second spawning but rather the collection of several individuals which had either spawned later than the bulk of the population or else were retarded in the redevelopment of the gonad.

Two spawning periods were recorded from the Pigeon Point population. The first of these took place between December 22, 1950, and January 6, 1951. On the latter date the sample consisted entirely of partially spawned animals and it was not until the following collection on January 21 that completely spawned specimens were found. This spawning was thus completed in about a month and by March 4 the animals had begun gonad redevelopment. The decline in the number of partially ripe animals which is again seen during late March and April is caused by the collection of two animals which were indeterminate. By May 13 a period of redevelopment had begun which continued until the spawning of the following year.



The second recorded spawning of the Pigeon Point group occurred between February 11 and February 25, 1952. On the latter date the entire sample was found to have spawned. It was possible to supplement these data by a few collections from Haven's Neck, Mendocino County, California. A sample of five animals from this locality taken on January 25, 1952, consisted of three males and two females, all of which were partially spawned. A second sample collected on February 22 included a single ripe male, while two other males and two females were either partially or completely spawned. Thus it may be concluded that over a distance of approximately 200 miles of open coast, this species is responding to a similar environmental stimulus which initiates spawning.

The most distinctive environmental factor which can be associated with the spawning of *Acmaea mitra* is that of the temperature. At the time of year when the species is spawning, both water and air temperatures are at or near their minima. In the January-February 1950 period, the mean water temperature was 48.5° F., the minimum for that year. The spawnings of 1951 and 1952 occurred at mean temperatures of 52.7° F. and 53.5° F., respectively, slightly above the minima for those two years.

A second feature to be mentioned is that in all three spawning periods a full moon was in evidence near the beginning of the two week interval during which the spawning was begun. These periods of full moon are associated with moderate tidal ranges of 7.4 feet, 6.7 feet, and 5.6 feet. Since the tidal amplitudes associated with the new moons which followed the spawning periods of 1950-1951 and 1952 are considerably greater (8.6 feet and 7.4 feet, respectively) than those of the full moon periods, it is suggested that the phase of the moon itself and not its associated tidal movements may be concerned with the initiation of spawning.

It may be mentioned, finally, that this is the one species studied in the present work which has never spawned in the laboratory. Even when the animals were in their ripest condition and exposed to sudden temperature changes or

sperm suspensions, they were never induced to spawn.

Literature Cited

- Boutan, L.
1898. Sur le development de l'*Acmaea virginea*. Comptes rendu hebdomadaires de l'Acad. Sci., vol. 126, pp. 1887-1888.
- Fritchman, Harry K.
1960. Preparation of radulae. *The Veliger*, vol. 3, no. 2, pp. 52-53.
- Grant, Avery R.
1937. A systematic revision of the genus *Acmaea* Eschscholtz, including consideration of ecology and speciation. Ph.D. thesis, University of California, Berkeley.
- Hewatt, W. G.
1938. Notes on the breeding seasons of the rocky beach fauna of Monterey Bay. *Proc. Calif. Acad. Sci.*, vol. 23, no. 19, pp. 283-288.
- Ricketts, E. F. and J. Calvin
1952. Between Pacific tides. (3rd edition). Revised by Joel W. Hedgpeth, Stanford University Press.
- Test, A(very) R. G(rant)
1945. Ecology of California *Acmaea*. *Ecology*, vol. 26, no. 4, pp. 395-405.
- 1946. Speciation in limpets of the genus *Acmaea*. *Contrib. Lab. Vert. Biol. Univ. of Mich.*, no. 31.
- Thiele, J.
1931. *Handbuch der Systematischen Weichtierkunde*, Jena.
- Thorson, Gunnar
1935. Studies on egg capsules and development in Arctic marine prosobranchs. *Meddel. om Groenland*, vol. 100, pp. 1-71.
- Willcox, M. A.
1898. Zur Anatomie von *Acmaea fragilis* Chemnitz. *Jenaische Zeitschr.*, vol. 32, pp. 411-456, pls. 17-19.
- 1905. Biology of *Acmaea testudinalis* Müller. *Amer. Nat.*, vol. 39, pp. 325-333.



Comments on Terms Used in Studies of Speciation Phenomena

by

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At the suggestion of the editor, the following remarks on terminology are offered as a preface to the paper by Harry K. Fritchman on reproductive cycles of central Californian limpets.

ECOLOGIC NICHE. To survive and to reproduce, an animal must satisfy all its essential needs for food, space, shelter, and breeding. At the simplest level, it is this totality of living requirements to which the term "ecologic niche" refers. Thus, niche used in the sense of a physical recess or place especially suiting a given animal species is used wrongly; for niche is not a synonym of habitat. Habitat, as the place where an animal is to be found, is certainly part of its niche, but the idea of niche refers as much to its other needs, or even more so, as will be brought out below.

Next we must say that the idea of niche is meaningless without the implicit recognition of the fact that any animal is associated with other organisms in a grouping characteristic for the given habitat, such as the high wave-washed rocky intertidal. Such a grouping is called a community. The members of this community use the space and the food available there, and presumably they use it so that their densities and their reproductive efforts are adjusted to the usual supplies of this space and food. To a varying degree animals with particular feeding habits, for example, vegetarians such as limpets, will get into each other's way because of similar food requirements. This will especially be true of closely related species such as our West Coast *Acmaeas*, which presumably exploit a lot of the available grazing opportunities. Even more so in their evolutionary histories these species competed for the same feeding opportunities. A great deal of this competition is now relieved by special adaptations in given species to particular segments of the total range within which limpets can graze, but this

does not mean they are cleanly separated in day-to-day life.

These comments now permit us to define "ecologic niche" in a more up-to-date way. A niche is the position of an animal in a community with relation to food and enemies. Now, by animal we of course mean a population that is maintaining itself. This population feeds on something, and other species feed on it. The supply of utilizable food is the most direct determinant of the presence of an animal, and it becomes superfluous to talk about place, or space, or breeding requirements, since these are all implicit in the idea of adequate food supporting the population. There are exceptions to this, but it holds in general and represents a backbone idea in a modern phase of ecology known as production ecology.

Thus, there are at least two ways of defining "niche": (1) As a totality of requirements. This is static. It gets us nowhere; it is a dead end. (2) As a position or occupation filled by an animal in the food-web of a community. This is dynamic. It recognizes the jig-saw puzzle character of a community and sets up an analytical framework for studies such as those of Fritchman.

ECOLOGICAL RANGE. In a community, some animals are restricted to particular places; others seem to range widely within the same community. Without knowing all the factors that set the narrow limits for species in the first group, we refer to them as stenotopic, literally meaning narrow place. To species in the second group we apply the term eurytopic, literally meaning wide place. As was stated above, there are wide grazing opportunities for limpets over most of the rocky intertidal; and the species present there have partitioned this range among themselves through evolution. Some of these segments are larger than average; others are smaller. Hence, eurytopic species and stenotopic species.

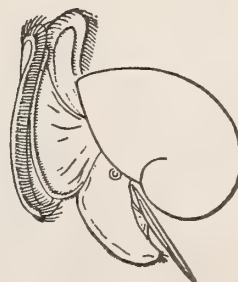
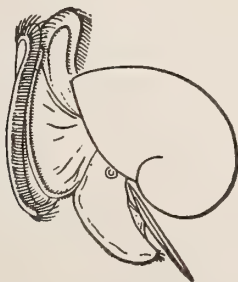
SPECIATION. When we have a group of closely related species such as the limpets, we have an opportunity to study factors which may have been critical in their evolution. Speciation is the process of species formation, and in one sense it is the process whereby a way of life or major occupation such as grazing in the rocky intertidal is divided into sub-occupations. In a small town, the supplying job is done by a general store; in a big city, the supplying job is divided according to commodities and then crosswise by the wholesalers, middlemen, and retailers. A natural community is simple or complex according to the same principles of economics. And in some complex communities we get a swarm of closely related species such as limpets whose very presence as so many variations on a basic theme raises intriguing questions. Did these evolve side by side, or did they evolve with long separations in space facilitating their radiation? This brings us to the two kinds of speciation about which students of evolution argue today.

(1) Geographic or allopatric speciation. The term allopatric is applied to distributional ranges of closely related species which complement each other in space; that is, they do not overlap. When this term is used as an adjective modifying speciation, it refers to a particular method of species formation. It is argued that the usual method, and for some students the only method, of speciation consists of the following three steps: first, a geographic separation of a continuous population into two parts; second, the occurrence of differences in the environments of the two populations followed by the divergence of these populations in behavior, physiology, and morphology so that they are respectively better adapted to parts of what was earlier the total environment occupied by the parent species; and third, the breakdown of

the original barrier separating the two populations so that they meet again, but now they do not interbreed and instead behave as distinct species. A barrier which was at first merely geographic is now supplanted by a genetic one, which has evolved as a part of the specializations each of the two populations acquired in their respective ranges while they were separated. This, in brief, is the theory of geographic or allopatric speciation.

(2) In the alternative and less popular method of species formation, by ecologic or sympatric speciation, we have a parent species giving rise to two species without the first condition required by the theory of geographic speciation, that is, without geographic separation. The derivative species co-exist through the period of species formation. The term sympatric means co-existing, and so ecologic or sympatric speciation refers to the formation of two species in one place and the acquisition of genetic isolation between them at some critical point without benefit of the reduction or prevention of interbreeding prior to this point that comes about automatically in geographic speciation. It can be contended, and has been contended, that a swarm of species such as the Acmaea limpets of the central Californian coast could evolve by local separations in time or space so that what was a single interbreeding population is chopped into two at some point because, say, one part likes to live on rocks, the other on snail shells; or because one part breeds in late winter, the other in mid-spring.

In giving us information on reproductive cycles of limpets, Dr. Fritchman addresses himself to this argument about geographic versus ecological speciation. In addition, and what is perhaps more important, he gives us information on the basic ecology of limpets that helps us to understand the impressive radiation that has resulted in this group through evolution.



Redescription of *Cypraea tigris lyncichroa* MELVILL, 1888

by

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(Plate 11)

The subspecies *Cypraea tigris lyncichroa* was described by Melvill in 1888. By subsequent consideration the existence of this shell as such has been questioned, and as a valid subspecies rejected (Iredale, 1939). There is a convincing basis for this action, as the true identity of the subspecies is obscure and confusing because of the inadequacy of its original description. While there is a lot of merit in Iredale's opinion, he undertook to do nothing about it. The purpose of this paper is to substantiate that such a form exists in Polynesia, to redescribe the subspecies, preserving Melvill's name for it, and to designate a hypotype.

Cypraea tigris tigris, Linnaeus, 1758, has a wide distributional range which extends eastward from the East African type locality to the Hawaiian Archipelago, and on a north-south axis from Japan to Australia.

In 1795 Shaw described a subspecies of *Cypraea tigris* which he called *C. tigris pardalis*. Since then, it has been established that this race ranges from Japanese waters through the Philippine-Sulu Sea area, Central Malaysia and the Andaman Islands to Northwest Australia. It was not until nearly one hundred years later that Melvill, while sorting over an accumulation of these shells from the central Pacific area, decided that there were enough color differences among them to permit subspecific classification. Thus, from a variety of dorsal color and design combinations, now known to be characteristic of this species as a whole, there appeared seven carefully chosen "varieties". These were:

- a. *Cypraea tigris flavonitens*
- b. *Cypraea tigris hinnulea*
- c. *Cypraea tigris russonitens*
- d. *Cypraea tigris chionia*
- e. *Cypraea tigris lyncichroa*
- f. *Cypraea tigris ionthodes*
- g. *Cypraea tigris zymecrasta*

Of these, *C. tigris lyncichroa* is being given special consideration here, the remainder being relegated to synonymy with *C. tigris tigris*.

In describing this subspecies, Melvill wrote only this: "... spotted and colored with blue and fawn pattern resembling *C. lynx* (Linnaeus), dorsal sinus reddish, very distinct, shell usually rather stunted, and smaller than other forms, sides and base white." Of the seven described varieties, this is the only one in which a reference was made to the shell itself rather than just the color and pattern — a reference which is applicable to almost any specimen one would stop to consider.

Melvill's descriptions make it practically impossible to associate them with any particular given population of *Cypraea tigris*. The color patterns of this species are notably variable, and, except for rare instances, can in no way be attributed to disease as has been suggested by Iredale. *C. tigris*' great range of color variability can be compared with the well-known examples of *Oliva miniacea* Röding, 1798 and *Mitra vulpecula* Linnaeus, 1767.

Among the many names proposed by Melvill, it is not clear how that of *lyncichroa* survived. His description is taxonomically too vague to be applicable to a specific population of mollusks, for the very reason that color forms and stunted specimens appear in every large population of this species. Even Melvill must have had a feeling of frustration in working with this group, when he said of his *Cypraea tigris chionia*: "This runs into *C. tigris flavonitens* frequently."

These superficially described characters could hardly have influenced Schilder (1939) in his choice of this inadequately established subspecies to represent the central Pacific populations of *Cypraea tigris*. It is difficult to understand why this subspecific name was chosen, with no more basis than this nebulous description.

I made as complete an analysis as possible of the color and morphological affinities of *Cypraea tigris*, tracing its growth patterns, its color forms, and its distribution from its East African type locality through Shaw's range of *C.*

tigris pardalis and on into its final stand in the northeastern Pacific. Until it reaches Hawaii, its actual morphological changes are few. However, very obvious differences in its general makeup become clearly apparent as the cline approaches its eastern terminus in the Hawaiian Archipelago. There is a unique natural element of ecological isolation to be observed in these islands that has been amply manifested in other molluscan genera found there.

Specimens from intermediate collecting stations westward were carefully considered for separating characters that would distinguish them from others, and except for the Hawaiian population, little variation was evident among them.

GENUS: *CYPRAEA* Linnaeus, 1758

SUBGENUS: *Cypraea* Linnaeus, 1758

Species: *tigris* Linnaeus, 1758

Subspecies: *lyncichroa* Melvill, 1888

Cypraea tigris lyncichroa (Melvill, 1888) (Plate 11, figs. 1 and 2); Mem. Proc. Manchester Soc., Ser. 4, Vol. 1, No. 5, p. 212. "*lyncichroa* (var. nov.). Spotted and coloured with blue and fawn

in pattern resembling *C. lynx* (L.), dorsal sinus reddish, very distinct; shell usually rather stunted, and smaller than the other forms, sides and base white."

I wish to expand this description as follows: Shell large, heavy, pyriformly ovate, acutely humped dorsally, bulbously inflated, posteriorly umbilicate; margins not obviously thickened, sides a continuous symmetrical curve from dorsum to base; extremities somewhat produced; base and lip sloping inward to denticles; aperture wide, straight, curving sharply left posteriorly; neither labial nor columellar teeth extend onto base. Labial teeth strong, wide, flattened, short; interstices deeply channeled, rounded; columellar teeth longer, finer, thickening pointedly on ventral columellar ridge and extending unbroken across fossula; fossula broad, increasingly concave anteriorly; terminal ridges hardly oblique; primary shell surface white or light beige, thickly covered with brownish-black spots which are superimposed upon larger blue spots formed in an earlier stage of development; base and teeth pure white; an orange-brown mantle line traverses the length of the right dorsum.

Table 1: Comparison Between Three Subspecies of *Cypraea tigris*.

Morphological Features	<i>tigris lyncichroa</i>	<i>tigris pardalis</i>	<i>tigris tigris</i>
Size Formula	126 (70) 21: 24	78 (71) 18: 16 *	89 (69) 17: 17*
Average Shape	Pyriformly Ovate, Humped	Ovate	Inflatedly Pyriform
Margins	Symmetrically Rounded	Less Angular	Regularly Rounded
Aperture	Wide	Less Wide	Wide, Sinuous
Lip	Generally Straight	Rather Declivous	Less Declivous
Labial Teeth	Broad, Flattened	Rounded, Short	Rounded, Lengthened
Columellar Teeth	Fine	Coarse	Often Slightly Finer
Fossula	Deeply Concave	Less Concave	Shallow
Fossular Denticles	Distinct, Continuous	Less Accentuated	Indistinct
Dorsum	White, Occasionally Cream	Mostly White	Often Yellowish
Dorsal Spots	Medium Distinct, Seldom Fused	Large, Often Fused	Smaller, Generally Fused
Base and Teeth	White	White	White

* Average Measurements, Schilder (1938).

Cypraea tigris lyncichroa differs morphologically from *C. tigris tigris* by its large size and heavier shell, its larger and stronger teeth, wider and straighter aperture, and its broader and deeper fossula (See Table I).

The type locality here selected of *Cypraea tigris lyncichroa* is Koko Head, Oahu (21°15' N. Lat., 157°43' W. Long.), with a probable range extending throughout the entire chain of eight Hawaiian Islands.

The hypotype was collected in 48 feet of water on an openly exposed lava substrate by Paul Fujimoto in March 1957. It will be deposited in the type collection of the Bernice P. Bishop Museum, Honolulu, Hawaii, where it will bear the catalog number 212'885.

In order to conserve a scientific name of long standing and to avoid complicating the literature, Melvill's subspecific name is herewith retained for this Hawaiian race. Further study will be necessary to determine how far westward the morphological influence of this subspecies extends and where it intergrades and overlaps with *Cypraea tigris pardalis* Shaw. It is reasonable to assume, however, that in this newly redescribed subspecies are to be found the elements of speciation Melvill must have had in mind when he noted a great variability of color in the shells of the central Pacific waters.

While no attempt is being made in this paper to use color as an identifying criterion in the description, it should be pointed out that in the Hawaiian area, the dorsal spotting retains a remarkable degree of constancy in the manner of its appearance. The large spots on a relatively plain dorsum, with a minimum of clouding or suffusing, are particularly striking.

It is of further significance that, unlike its related subspecies, *Cypraea tigris lyncichroa* survives and maintains itself in a deep-water habitat. Few records exist of its ever having been collected alive intertidally. Within the limits of the presently considered range, the Hawaiian Islands, it has been noted by observant collectors that *C. t. lyncichroa* varies in its ecological requirements from one island to the next. It is usually found in approximately ten feet at Hawaii, the southernmost station considered here; in 15 to 20 feet near Maui, and in 25 to 40 feet around Oahu, still farther north. The smaller shells seem to come from the shallow localities in the southern end of the range, medium-sized ones from the intermediate depths of mid-range, and the largest known in the world from the deep-water Oahu stations. Unlike most other *Cypraea* of nocturnal habits, *C. t. lyncichroa* is less shy, remaining boldly

out in the open during daylight hours. It has been further noted that animals of this subspecies are usually to be found in pairs.

The animal of *Cypraea tigris lyncichroa* has a snow-white mantle that is variously covered with medium brown blotches which increase to a very dark brown at the center. The paintbrush tips of the numerous brown papillae are flecked with white.

Kay (1957) has described the stomach contents as algae and sponge.

The subspecies *lyncichroa* is found uncommonly in Hawaii, and its life history there is vague. Four early conchological works, Marten & Langkavel (1871), Baldwin (1898), Garrett (1879), and Hidalgo (1906) record this shell in Hawaii before 1906, but these reports are regarded by Schilder (1933) as doubtful. The first authentic mention of the subspecies is by Harris (1935) who reported that Edward K. Nihipali, an Hawaiian fisherman, had in 1929 collected one of the largest specimens on record, 5 $\frac{3}{4}$ " long. This specimen was collected alive on the edge of the reef at Hauula, Oahu, in six feet of water. *Cypraea tigris lyncichroa* is not known to exist in the late Hawaiian Pleistocene.

Acknowledgment

It is with a great deal of personal warmth and appreciation that I acknowledge the help given me in the preparation of this paper by my friend and co-worker Clifton S. Weaver of Honolulu. Special thanks are also given to Mrs. John Q. Burch for access to reference material in her library. The photographs are by Lowell Weymouth.

Literature Cited

- Baldwin, D. D.
1898. Hawaiian Cypraeidae. *Nautilus*, vol. 11, p. 123.
- Garrett, Andrew H.
1879. *Jour. Conch.*, vol. 2, p. 105.
- Harris, Wray
1935. *Cypraea tigris* Linné in the Hawaiian Islands. *Nautilus*, vol. 49, no. 2, pp. 39-41.
- Hidalgo, J. G.
1906. Monografía de las especies vivientes del género *Cypraea*. *Mem. Ac. Cienc. Madrid*, vol. 25, p. 182.
- Iredale, Tom
1939. Australian Cowries. *The Australian Zoologist*, vol. 9, pt. 3, p. 303.



Figure 1

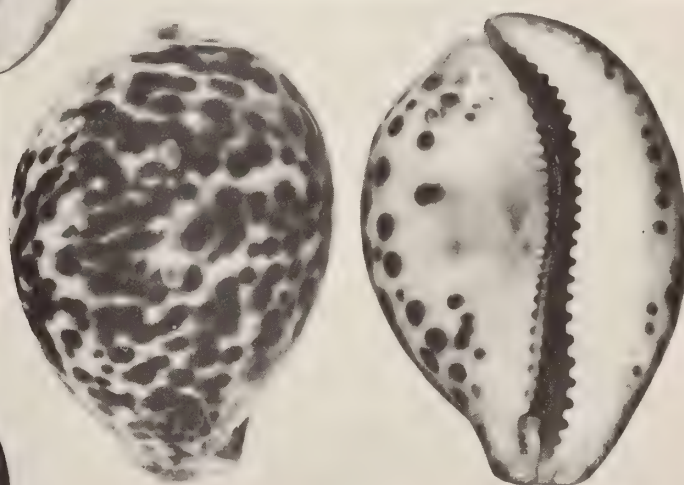


Figure 2



Figure 3

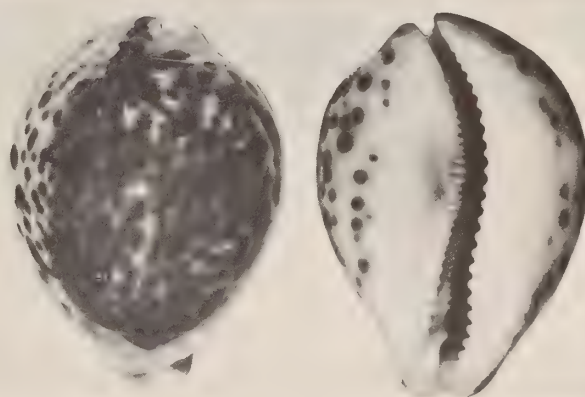


Figure 4

Dorsal and Ventral Aspect of Hypotypes:

Figure 1: *Cypraea tigris lyncichroa* MELVILL, 1888

Figure 2: *Cypraea tigris lyncichroa* MELVILL, 1888

Figure 3: *Cypraea tigris tigris* LINNAEUS, 1758

Figure 4: *Cypraea tigris tigris* LINNAEUS, 1758

Kay, Alison

1957. Systematics of the Cypraeidae. Thesis. University of Hawaii.

Marten & Langkavel

1871. Südsee-Conchylien: Donum Bismarckianum, p. 65. Berlin.

Melville, James Cosmo

1888. A catalogue of the species and varieties of *Cypraea*. Mem. Proc. Manchester Soc., Ser. 4, Vol. I, No. 5, p. 212.

Schilder, F. A.

1933. Cypraeacea from Hawaii. Bernice P. Bishop Museum Occ. Papers, vol. X, no. 3.

Schilder, F. A. and M. Schilder

1938. Prodrome of a monograph on living Cypraeidae. Proc. Mal. Soc. Lond., vol. 23, pt. 3, p. 185.

Shaw, G.

1795. Vivar, natur., Natur. Misc., 6, t. 193.

Basic Lighting for Shell Photography

by

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(Plate 12, 3 Textfigures)

This article is a summary of standard methods of lighting which will result, if properly handled, in good photographic representations of small objects in general and shells in particular. The usual requirements in this field are that there should be good visual separation from the background, detail should be apparent in all subject areas without too-distracting harsh shadows, and that surface characteristics of the individual piece should have little or no obscuring effect.

Due to space limitations it will be assumed that the reader has a general knowledge of camera use and photographic processing. It will also be assumed, as the figures indicate, that the camera used will be of the vertically mounted cut-film type.

Although there are probably as many solutions to any photographic problem as there are participating photographers, there are really just a few basic approaches. The most important of these for our purposes are the three types of lighting setups shown in text figures 1, 2, and 3. The method illustrated in fig. 1 is both simplest and of the most use. In order to separate the subject from the background the shell is placed on a glass plate which is held elevated above the white background sheet by sufficient distance to cast any subject-shadow off and out of the picture area. To accomplish all these objectives only one light source is needed, and it is placed as indicated. The harsh

single source light is then softened by the use of a translucent diffuser, usually a piece of

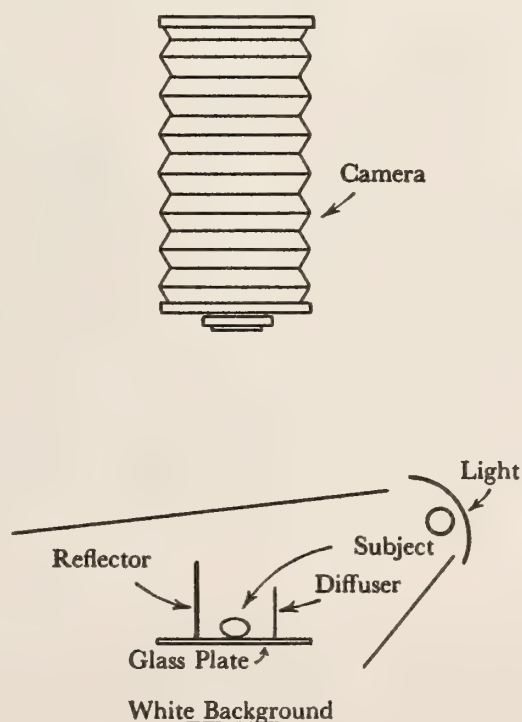


Figure 1

drafting tracing tissue curved and/or supported so that it will stand by itself between light and subject. Finally, the dark shadows now formed on the side opposite the light are illuminated and approximately balanced with a similarly curved white paper reflector. This can be made of white photo blotter, tagboard, or other fairly stiff material.

The prime virtue of the reflector-diffuser system is that it provides soft, even illumination whose directionality and balance between light and shadow areas can be altered at will to give anything from almost perfectly flat featureless lighting to contrast between light and shade equal to or exceeding the ability of the film to record it. Though the basic setup is as above, it should be remembered that all subjects do not require the same setup. In some cases, especially where surface detail or texture is particularly important, it may be desirable to omit the diffuser and use only the reflector. In this case additional separate lighting of the background is usually required to insure adequate visual separation. Many cases will require not one but several variously placed reflectors to properly show all detail. However, nearly any job of photography in this field can be adequately illuminated using this basic technique and its variants. Plate 12, figure 1 is an example of basic reflector-diffuser lighting with the reflector placed to give an intermediate degree of fill in dark areas.

To return briefly to the matter of background separation, let it be noted that only three alternatives exist for all practical purposes. The background must be white, black, or grey (in color photography grey is of course paralleled by unlimited choice of color, but here I am assuming the uses of black-and-white work). A white background is obtained by the method previously described, the background paper, being directly lit without diffusion (see diagram), receives enough additional light to assure that it will go either pure white or very close to it in the print. Deterioration of image quality is inherent in half-tone reproduction, but greatest clarity is retained with the white background. Black and grey tend to merge with the subject and result in a muddy appearance in all but the very best reproduction. True blacks are never really attained. Black backgrounds are suitable only when the subject is so light in color as to be lost against white. Here special care must be taken to insure adequate light to all edge areas, so that shadowed portions will not blend into the background. Plate 12, figure 2 is the same subject as figure 1, and is lit identically; the only difference being the background

color; notice that the shell does not clearly separate from it in any but primarily edge-lit areas. Grey backgrounds should be avoided except where the subject contains both very light and very dark areas in such combinations as to render photography impractical against either white or black. When black is to be used simply lay the subject directly on a piece of black velvet (few other materials are light-absorbent enough to print black in the final result). Subject shading of the background of course simply blends into the rest of the blackness. For grey backgrounds use any suitably grainless grey material, either directly under the subject or with the subject raised on a pedestal. Cancellation of subject shadows is left to the reflector-diffuser combination and is sometimes not complete.

With this basic lighting the major remaining difficulty is that of disturbing surface characteristics, the main one being extreme glossiness. Since a very shiny surface is essentially a mirror, the photographer will find that reflectors and diffusers, while distributing the light correctly, will leave their images apparent on the photograph. This can be seen in Plate 12, figure 4. This writer has found only one good solution, and that is to place the subject, where practical, under water or other liquid of suitable refractive index in a glass-bottomed dish. Plate 12, figure 5 was set up and lit identically to Plate 12, figure 4 - that is, with simple reflector and diffuser. The sole difference was that the subject was under water. Under these circumstances the surface of the shell was no longer a reflecting air contact. Instead, the water surface was the only shiny surface and since it was at the correct angle with respect to the light source it was rendered transparent. The result of this procedure is that all gradations in the print, from light to dark, are due to coloration in the subject matter and all such coloration shows without interference from surface effects. This is plainly not the case in Plate 12, figure 4.

For special needs there are two other basic means of getting suitable light upon the subject. The first of these is illustrated in text figure 2. With camera and subject mounted in the proper relationship a small fluorescent ringlight is introduced between as shown. Its height above the subject is adjusted to produce the desired effect and that is all there is to it. An example of this lighting is in Plate 12, figure 3. The result is an extremely soft, even light which, while throwing no shadows visible to the camera, very nicely indicates both shape and coloration. It also provides exceptionally good separation



Figure 1



Figure 2

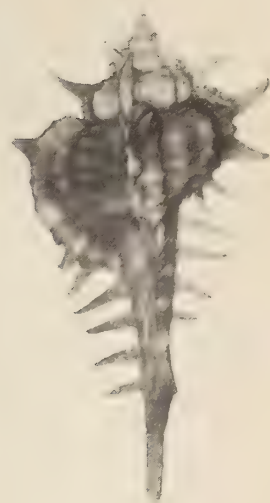


Figure 3



Figure 4

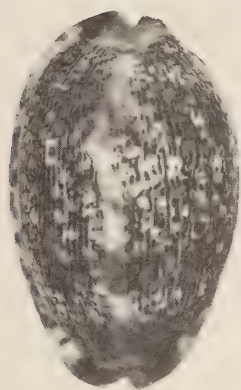


Figure 5

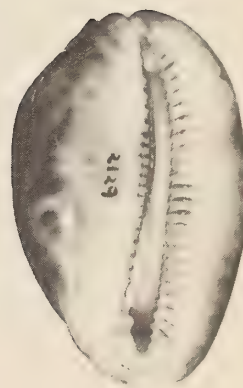


Figure 6

See Text for Explanation

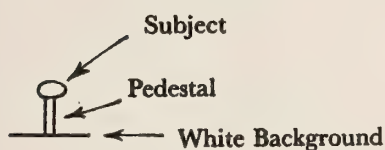
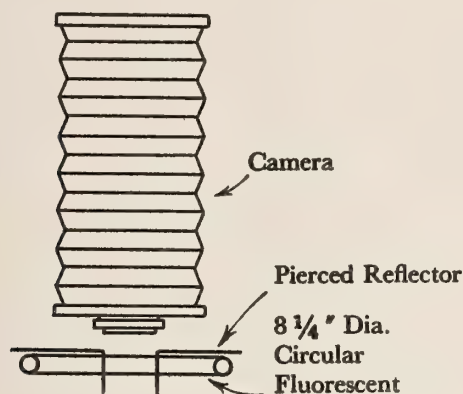


Figure 2

from the background, as all surfaces curving off the horizontal become slightly darkened through lessened reflectance in the direction of the lens. Since a glass plate under the subject would reflect an image of the ringlight the background is separated from the subject only by a pedestal of modelling clay of sufficient height to allow dissipation of the penumbra produced by subject shading of the background. In some cases it may be desirable to separately light the background.

There are several disadvantages to this method of lighting in addition to the background problem mentioned above. One is that there is no directionality in the lighting. Another is that it is suitable only for non-shiny subjects. On shiny subjects an image of the light source surrounds the highest point on its surface. Placing the subject under water results only in a photograph of the light source as reflected from the water surface, the subject itself being completely obscured. Hence, this method is not as universally useful as the previous one. For some purposes, however, it has distinct advantages. Due to the nature of fluorescent lighting the method is not suitable for color work.

The last of the methods to be covered here is illustrated in text figure 3 and features the use of a controllable light beam in conjunction with a beam-splitter mirror. Such mirrors are obtainable fairly readily from surplus houses and optical suppliers. The lighting obtained by this method differs from all others in that it is axially directed, that is, it seems to have come down through the axis of the camera lens. This results in several things. One is that one does not photograph areas of light and shadow but rather the degree to which light is reflected back from the subject. A horizontal surface sends back toward the lens nearly all the light put on it, while a surface tending off horizontal sends back less and less light the further off horizontal it goes. The result here is the intensified rendering of shapes, without regard to whether the surface is rough or smooth. All surface irregularities and other variations from the horizontal are made very apparent, and the method is particularly well suited to showing fine surface detail in relatively flat subjects.

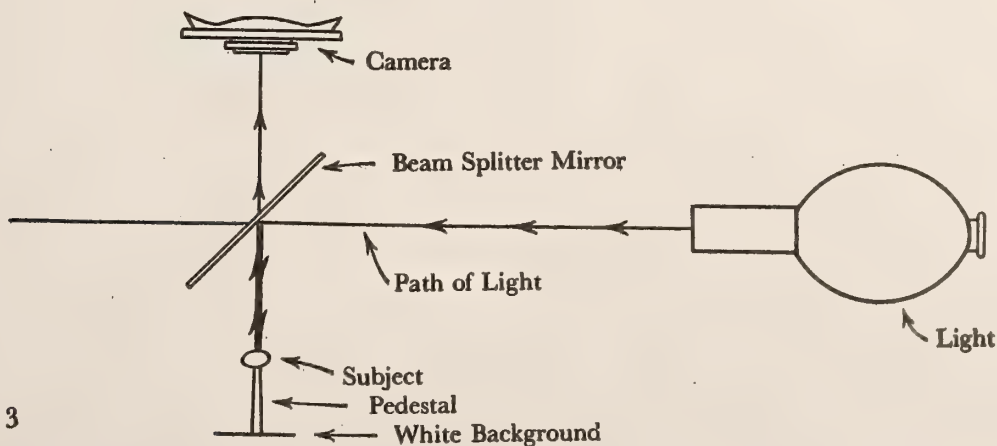


Figure 3

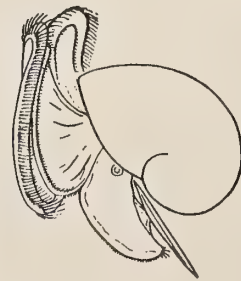
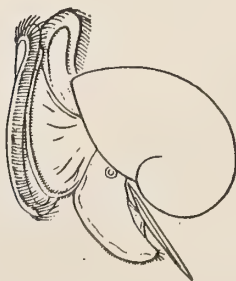
Plate 12, figure 6 is an example of this type of lighting. Note that the "teeth" about the central opening are rendered very clearly and without the obscuring shadows that would result from oblique lighting. Also note that the edge of the shell, all the way around, is clearly delineated by a dark line formed by its own lessening of reflectance as described above.

Another major advantage of this system, in addition to that mentioned above, is its ability to clearly illuminate the deepest of cavities. Note in Plate 12, figure 6, that the very deep and narrow central opening is as clearly shown as is the outside of the shell. No other means of lighting can equal this penetration of narrow deep cavities. The ringlight method described previously is near axial in effect, and certain small electronic flash rings are somewhat more so. The beam-splitter method is actually axial and makes possible such feats as photography down a gun barrel.

This method has fewer applications than the first method described and in its optimum form is the most difficult to set up and control. It also has certain inherent disadvantages in application. First, the mirror itself must be carefully mounted in a box which is lined with light absorbent material. This box has only three openings, one each to the light, the subject, and the camera lens. If it is not so mounted, there will be crippling difficulties with reflections on the mirror. Next, for maximum versatility the light source should be controllable to produce converging, parallel, and diverging beams. This allows widely differing results in practice. Good work can be done with ordinary spotlights or even floodlights or slide projectors as sources, but the full possibilities cannot so be exploited.

In all cases, of course, the subject must be shaded so that the only light it receives will be from the mirror. Shiny materials, such as that used in Plate 12, figure 6, will show small hard areas of reflectivity which, according to one's needs, may or may not bother. Coloration in edge areas of deeply curved subjects — such as the one illustrated — is obscured by the inherent edge shadowing, though the amount can be controlled by varying the character of the light beam. Photography through glass or liquids results only in light source images. A great deal of light — about 75% — is lost since on each contact with the mirror about half of the existing light is reflected or passed through in useless directions. The mirror itself must be optically flat on both sides and the sides must be exactly parallel, if one is not to suffer image deterioration. The only exception to this last is that if the glass is sufficiently thin the aberrations can, to some extent, be ignored, especially if the negative is not going to be enlarged in printing. Thus, very small items can be photographed this way using a microslide cover glass as a mirror with fair success. For use in color photography one must have a mirror which does not itself color the light, as most coated beam-splitters do. Lastly, the size of the subject to be photographed is limited by the size of mirror available. However, with all these disadvantages there are still times when nothing else will do.

In closing let me say that the selection of lighting method should, where possible, be determined by the results desired. In most cases the first method described is entirely adequate if well handled, the other methods being described to help out in extraordinary situations.



Food and Feeding Behavior in *Conus californicus* HINDS, 1844

by

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and

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(Plate 13)

(These studies were aided in part by a contract between the Office of Naval Research, Department of the Navy, and the University of Southern California, NR 107-342.)

(The authors are grateful to Dr. Olga Hartman and Normal Tebble for identification of the polychaetes described in this report.)

Conus californicus Hinds, 1844, is the only species of *Conus* occurring in California. Little information is available upon the nature of the food or the feeding habits of this species. Hinegardner (1957) reported single observations of *C. californicus* feeding upon dead specimens of *Olivella* and *Octopus bimaculatus* Verrill and a nearly dead *Tegula funebris* (A. Adams, 1854). He also observed apparent attacks upon a large polychaete and upon *Jaton festivus* (Hinds, 1843), neither of which were killed. MacGinitie and MacGinitie (1949) observed *C. californicus* feeding upon the tectibranch *Phyllaplysia zostericola* McCauley, 1960. We have recently investigated the feeding behavior in *C. californicus* under aquarium conditions, and have also made a few observations of feeding activities in the field.

In common with other species of the genus *Conus*, *C. californicus* possesses a venom apparatus with a small radula tooth, venom duct and venom bulb (Hinegardner, 1957; 1958; Hanna & Strong, 1949). Other species have been shown to feed on fish, other gastropods and a variety of marine worms (Kohn, 1956; 1959), using their venom apparatus as an aid in capturing their prey (Kohn et al. in press). Certain tropical species have also stung human beings with results ranging from relatively mild local effects to death in some cases (Clench & Kondo, 1943; Hermitte, 1946; Kohn, 1958). We are not aware of any instances of stings of human beings by *C. californicus*. Although the venomous nature of *Conus* has been known from such evidence for many years, an experimental proof of the existence of a venom has only been presented recently (Kohn, et al. in press).

Method & Results

Collection of specimens.

Conus californicus was collected in either the San Diego Flood Control Channel or in Mission Bay, San Diego; specimens ranged in size from 18 mm. in length to a maximum of 32 mm. (mean length about 20 mm.). The animals were maintained at approximately 21°C. in an aerated ten-gallon aquarium. Animals tested as possible prey organisms were collected in the same areas or at Point Loma unless otherwise noted, and were maintained under the same conditions in separate aquaria. Although the cones in this study were given food at intervals of about a week or less, others have remained alive for periods up to two months without any food.

Results of feeding experiments and field observations

Specimens of *Conus californicus* in the absence of prey were buried in the sand much of the time and only occasionally moved about. The proboscis was never observed to be extended under these circumstances. Introduction into the tank of animals subsequently stung resulted in many of the cones emerging from the sand within minutes and extending the white proboscis up to a length equal to that of the shell. No extension of proboscis or other indication of activity occurred following introduction of species which were not stung; in these cases animals which had been previously found to be stung were introduced subsequently in order to establish that the cones were in good condition, and

the usual stinging and feeding occurred.

The responses to the introduction into the aquarium of various animals are given below, together with a number of observations made in the field. The results are summarized in Tables 1 and 2. The introduction of the polychaetes listed in Table 1 almost always led to attacks by Conus californicus; on the other hand, the gastropods enumerated were often not stung.

Table 1

Animals stung and eaten in the aquarium by <i>Conus californicus</i> HINDS, 1844	
Animal Species	Number of Observations
Gastropods:	
<i>Nassarius tegulus</i> (REEVE)	45
<i>Nassarius perpinguis</i> (HINDS)	28
<i>Nassarius fossatus</i> (GOULD)	6
<i>Nassarius mendicus</i> (COOPER)	5
<i>Polinices reclusiana</i> (DESHAYES)	6
Polychaetes:	
<i>Glycera dibranchiata</i> EHLERS	18
<i>Glycera americana</i> LEIDY	4
<i>Pareurythoe californica</i> (JOHNSON)	2
<i>Lumbrineris</i> sp.	2
<i>Eunice</i> sp.	3

(1) NASSARIUS

Most of the experiments with this genus were carried out with Nassarius tegulus (Reeve, 1853) (mean length 16 mm.) and N. perpinguis (Hinds, 1844) (mean length 20 mm.). Specimens of Conus californicus stung the victim (Figure 1) in the foot after contact had been made with the proboscis; the Nassarius was sometimes held to the tip of the proboscis for a minute or longer, although usually the animals escaped after 15 seconds or less. A white "cloud" of material was often discharged from the tip of the proboscis at the moment of stinging. The Nassarius usually withdrew its foot into its shell for a short time, but in those cases in which the animal was killed, the foot often was extended in a flaccid condition some time later. Feeding by C. californicus began by opening of the mouth and attachment to the foot of the Nassarius, and feeding continued for one-half to several hours, after which time the victim was usually completely consumed.

In some cases the proboscis remained attached to the foot (presumably by means of the radula tooth) in spite of violent movements by the Nassarius. The cone then attempted to feed, using the foot to immobilize the Nassarius. In those cases in which the Nassarius was held for about 15 seconds or longer, paralysis and eventual death occurred at times, although occasionally the victim recovered after some hours. It is clear that a single specimen of Conus californicus can kill a Nassarius, but that the latter also frequently survives the attack.

Table 2

Animals observed being eaten by <i>Conus californicus</i> in aquarium (a) or field (f) (no evidence of stinging)		
Animal	Number of Observations (a) (f)	
Gastropods:		
<i>Nassarius fossatus</i> (GOULD)	7	1
<i>Bulla gouldiana</i> PILSBRY		4
<i>Olivella biplicata</i> (SOWERBY)	30	7
<i>Astraea undosa</i> (WOOD)		1
<i>Polinices reclusiana</i> (DESHAYES)	3	
<i>Norrisia norrisii</i> (SOWERBY)	6	
Pelecypods:		
<i>Solen rosaceus</i> CARPENTER		1
<i>Chione californiensis</i> (BRODERIP)		1
<i>Macoma nasuta</i> (CONRAD)		4
unidentified <i>Pecten</i>		1
<i>Tagelus californianus</i> (CONRAD)		1
<i>Tellina arenica</i> HERTLEIN & STRONG		1
Polychaetes:		
<i>Arenicola cristata</i> STIMPSON		1
<i>Glycera robusta</i> EHLERS		1
Other:		
Octopus	1	
Fish	3	1

If the Nassarius was held long enough to permit the cone to use its foot to hold the victim, the latter seldom escaped. Frequently, a number of specimens of Conus californicus attacked a single specimen of Nassarius, and under these circumstances the latter was almost always subdued and eaten.



Figure 1



Figure 2A



Figure 2B



Figure 3

Figure 1: *Conus californicus* HINDS (viewed from ventral side) with proboscis (below siphon) extended just prior to stinging *Nassarius tegulus* (REEVE) (held in forceps).
 Figures 2A and 2B: *Conus californicus* feeding upon *Nassarius fossatus* (GOULD). Note relaxation of foot of latter. Figure 3: *Conus californicus* feeding upon polychaete (*Glycera*). A second cone is seen approaching with proboscis (white structure) extended.

We occasionally observed multiple attacks by Conus californicus upon Nassarius fossatus (Gould, 1849) (mean length 42 mm.). Swelling soon appeared at the site of the stings, followed by marked relaxation of the foot and subsequent death in some cases. As many as 15 specimens of C. californicus have been observed feeding upon a single N. fossatus (Figures 2A and 2B). After an hour or so of feeding, the cones were sometimes pulled away from the victim, and a "thread" of tissue up to about one inch in length could be withdrawn from the cone (a similar observation was made by Hinegardner (1957).

(2) OTHER GASTROPODS

Attacks upon Polinices reclusiana (Deshayes, 1839) have been observed in the aquarium occasionally. A sting by a single cone produced a swelling at the site of the sting, and repeated stings by other specimens soon produced an apparent inability of Polinices to withdraw its foot into its shell. Large numbers of cones (up to 24) have been observed feeding upon individual dead specimens of Polinices after such attacks.

We have maintained the following species in the aquarium with Conus californicus for long periods of time without evidence of their being stung: Tegula funebris (A. Adams, 1854), Bulla gouldiana Pilsbry, 1895, Astraea undosa (Wood, 1828), and Norrisia norrisi (Sowerby, 1838). (We have observed a few instances of cones feeding upon dead specimens of the last-named three species, however.)

(3) OTHER MOLLUSKS

No other mollusk has been observed being attacked by Conus californicus. However, we have seen cones feeding upon a number of dead pelecypods in the field (Table 2). A moribund Octopus was placed in the aquarium on one occasion, and a number of specimens of C. californicus stung and then commenced to feed upon it. Cones have also fed upon small pieces of the foot of Haliotis fulgens Philippi, 1845, in the aquarium.

(4) POLYCHAETES

The introduction of various species of polychaetes provoked stinging attacks almost without fail, while on many occasions the cones did not attack Nassarius. The worm was often held after being stung, presumably by the barbed radula tooth, and ingestion began without contact

being broken. On other occasions cones approached worms with open mouth (but without the proboscis extended) and simply began to feed with no evidence of stinging. It is not known if worms can be killed by the sting; they continued to writhe about while being ingested by one or more cones. Worms which had been stung but then escaped exhibited swelling at the site of the sting. Examination of the bottom of the aquarium approximately 24 hours after the cones had fed upon Glycera revealed a number of radula teeth. The worms attacked and eaten are indicated in Table 1; all were collected locally, with the exception of Glycera dibranchiata Ehlers, which was purchased in local bait stores. Six average-sized specimens of Conus californicus have, together, completely consumed worms of this species several inches in length. Figure 3 shows a Glycera being ingested by one cone, while a second approaches with proboscis extended prior to stinging.

In the aquarium, Conus californicus also fed upon live specimens of the oligochaete Tubifex; the worms were usually ingested without being stung, although stinging was observed on occasion. Live specimens of unidentified earthworms were also stung and eaten repeatedly in the aquarium.

In the field, more than a dozen cones were found attached to and presumably feeding upon a live specimen of Arenicola cristata Stimpson, 1856, which was about six inches long; one instance of feeding upon Glycera robusta Ehlers, 1868, was also noted. Other feedings upon worms have been noted occasionally in the field under circumstances not permitting identification of the worm.

(5) OTHER OBSERVATIONS

Specimens of Conus californicus in the aquarium have been observed attached to and presumably feeding upon dead or nearly dead specimens of fish collected in local tide-pools (Clinocottus analis australis Hubbs, Hypsoblennius gilberti, and other fishes); in addition, on one occasion a cone was observed ingesting an entire small dead fish in the field. Cones in the aquarium fed frequently upon small pieces of cut mackerel or barracuda. We have, however, maintained healthy specimens of Clinocottus (mean length 50 mm.) in the aquarium for weeks with no evidence of attack by C. californicus. This is in contrast to our unpublished observations on Conus striatus which readily attacked and ate this species.

Summary

The feeding behavior of Conus californicus has been investigated under aquarium conditions. Gastropods of the genera Nassarius and Polygones and a number of species of polychaetes have been stung and eaten under these conditions. In the field, C. californicus has been observed feeding on dead specimens of a number of species of gastropods, pelecypods, polychaetes and fishes. C. californicus is, therefore, less specific in its food habits than many species of Conus which were found by Kohn (1959) to feed exclusively upon either polychaetes or other gastropods or fishes.

Literature Cited

- Clench, W. J. and Y. Kondo
1943. The poison cone shell. Amer. J. Trop. Med. Hyg., vol. 23, pp. 105-120.
- Hanna, G. D. and A. M. Strong
1949. West American mollusks of the genus Conus. Proc. Calif. Acad. Sci. (4th series), vol. 26, pp. 247-322.
- Hermitte, L. C. D.
1946. Venomous marine mollusks of the genus Conus. Trans. Roy. Soc. Trop. Med. & Hyg., vol. 39, pp. 485-512.
- Hinegardner, R.
1957. The anatomy and histology of the venom apparatus in several gastropods of the genus Conus. Thesis, University of Southern California.
- 1958. The venom apparatus of the cone shell. Hawaii Med. J., vol. 17, pp. 533-536.
- Kohn, A. J.
1956. Piscivorous gastropods of the genus Conus. Proc. Nat. Acad. Sci., vol. 42, pp. 168-171.
- 1958. Recent cases of human injury due to venomous marine snails of the genus Conus. Hawaii Med. J., vol. 17, pp. 528-532.
- 1959. The ecology of Conus in Hawaii. Ecol. Monographs, vol. 29, pp. 47-90.
- Kohn, A. J., P. R. Saunders, and S. Wiener
in press. Ann. N. Y. Acad. Sci.
- MacGinitie, G. E. and N. MacGinitie
1949. Natural history of marine animals. McGraw-Hill, New York.

Rediscovery of Cypraea marginata GASKOIN, 1848

by

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(Plate 14)

It seems important that mention be made of one of the most interesting discoveries in recent years among the Cypraeidae, namely a second specimen of Cypraea marginata Gaskoin, 1848. This live-taken specimen came to me with the acquisition of the fine Cypraea collection made by the late Lloyd E. Berry after his death in October 1959. Mr. Berry had surmised that his shell was C. marginata when he received it among a mixed lot of specimens sent him by a fellow collector in Australia, but owing to his frail health was unable to follow through and have its identification authenticated. It is now my pleasure to realize this wish on his behalf.

Gaskoin's holotype of Cypraea marginata is in the British Museum. Due to its uniqueness, various authors in the past have questioned the validity of this species. Tryon (1882), Hidalgo (1906), and Allan (1956) all refer to it as either a juvenile or an abnormal specimen of C. theersites Gaskoin, 1848. Schilder (1930) compares it with C. friendi Gray, 1831, though recognizing C. marginata as valid. The discovery of the second specimen of C. marginata, matching as it does all the features of the holotype, should put an end to the conjectures of the past as to whether or not the species is valid. Although it exhibits a close relationship to C. theersites, and to a somewhat lesser degree to C. friendi,

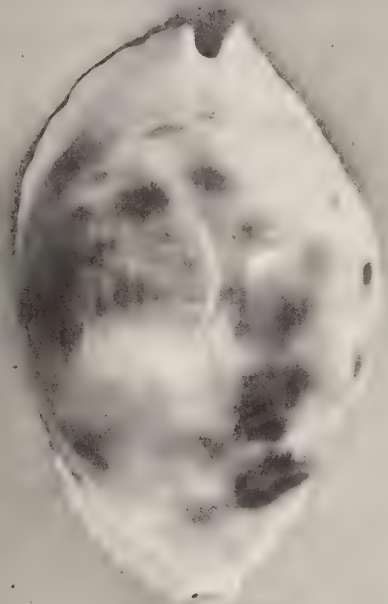


Figure 1

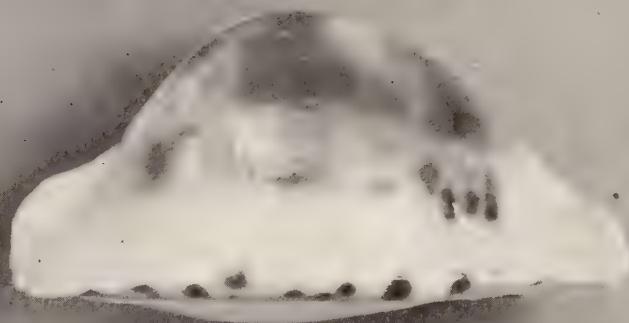


Figure 2

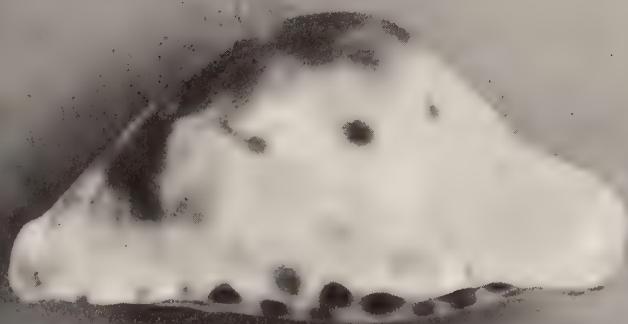


Figure 3



Figure 4

Cypraea marginata GASKOIN, 1848

Figure 1: Dorsal Aspect

Figure 2: Right Side

Figure 3: Left Side

Figure 4: Ventral Aspect

it seems fairly evident that C. marginata has been very properly described by Gaskoin as a separate species.

Because of its rarity, conchologists understandably would hesitate to accept such a species with no additional substantiating specimens; any unique specimen can be suspected of being an aberrant form of a known species until further proof of its validity is found. However, we feel that the remarkable degree of similarity in morphological characteristics between the newly discovered specimen and Gaskoin's holotype, described 113 years ago, provides the necessary proof that Cypraea marginata is indeed a separate species.

Gaskoin's original description, from the Proceedings of the Zoological Society of London, 1848, is as follows:

"Shell ovate, anterior end rather pointed, the posterior and middle very gibbous; of a cream-colour, a few fulvous spots are irregularly scattered over the entire back and sides of the shell, apparently the commencement of the disposition of colouring-matter; base flat and very broad, on the outer edges are discrete fulvous brown spots, the rest of the base, the teeth, and the interior of the shell are of a clear cream-colour; aperture wide, spiral; columella gibbous posteriorly, a slight sulcus at the anterior end; teeth form, on the columella side, a single angular serrated edge, about twenty in number, wide apart and not very prominent; on the other side they are more regular and even, extending, slightly prominent, half across the lip; they are smaller and more perfect towards the anterior extremity, and about twenty-nine in number; the extremities are produced, flat, form a broad channel, passing upwards at the posterior end of the shell, and terminate at the outer side of the apex of the spire; the anterior extremities are much less produced, and converge, forming a short channel running upwards; spire very prominent; margins flat and thin, extending much outwards; the angle formed by the attachment of the outer margin to the shell is of a light brown colour, from which anteriorly radiate lines of the same colour over the upper surface of the margin.

"Differs from Cyp. Scottii in its short and gibbous form, in the remarkable flat and broad cream-coloured base, in the very extended, flat and thin margins; the posterior channel has much the form of that of

Scottii, but terminates at the apex, and not, as in Scottii, at the base of the spire. (C. Scottii Broderip, 1831 = C. friendi Gray, 1831.)

"Length, 2 25/100 inches; altitude, 1 20/100; breadth, 1 50/100.

"Hab.-----?"

Although I have not personally examined the type in the collection at the British Museum, photographs of all four aspects of my specimen (See Plate 14) were sent to the Mollusca Section of that institution for comparison. I wish here to express my gratitude to Mr. I. C. J. Galbraith and to Mr. Peter Dance for their interest in this study and for their prompt response to my request for the comparison of these photographs with the type specimen. I quote their conclusions from a personal communication from Mr. Dance, September 3, 1960:

"I think there can be little doubt that your specimen is very similar to ours and, I should say, represents the same species. Whether marginata itself is a good species or not, I am in no position to say, but the existence of two specimens should support the idea that marginata is not just a freak of some other species.

"Compared with your photographs the holotype shows many points of resemblance. 1. The margination of the base is very similar though our specimen is somewhat chipped around the base. 2. The "concavities" are certainly present on the base of our specimen though not entirely confined to the brown spotted areas. This seems to be a good character. 3. The teeth are very similar although they are slightly more numerous in our specimen. 4. The brown spotting on the base and side are similar in both but our specimen is irregularly spotted on the dorsum whereas yours is uniformly coloured. The posterior and anterior extremities of our specimen are creamy pink.

"Our register entry reads as follows:

'42.7.7.7. [B. M. (N. H.) Register No.]. Cypraea, young (unique) New Holland. Purchased at Steven's sale. £3.17.6d.'

"... the register number... implies that the B. M. acquired the specimen in July 1842."

Perhaps one of the most notable features of Cypraea marginata, which distinguishes it from all other known Cypraeids, is the presence of well developed brown pits or concavities in the area of the lower margins and base, creating

undulations along the marginal edges. Other unusual features not ordinarily encountered in *Cypraea* are the sharply margined sides and the expanded marginal flare in the area of the terminal collars. The well extended spire is curiously enveloped in the left flange of the posterior canal. (In the holotype, the terminal flanges are broken.) Noteworthy, too, are the lengthened labial teeth. These features and the remarkable undulating marginal ridges seem to be constants in the species.

The hypotype measures 47.5 mm. long, 29.1 mm. wide, and 23.5 mm. high. There are 18 columellar teeth and 26 on the lip, two of which are vaguely bifid. The presence of more numerous teeth in the holotype, as pointed out by Mr. Dance, may be attributable to its being a larger shell, 12 mm. longer than the specimen described here. Using the formula developed by the Schilders (1938), this specimen compares with the holotype as follows:

Holotype.....[59.4 (62) 29:23]

Hypotype.....[47.5 (62) 26:18]

It may be of interest to record that on the left side and base, where they are most abundant, there are 21 spots and concavities on the hypotype, with 13 appearing on the right side.

This specimen was trawled from approximately 80 fathoms within the perimeter of Albany Bay, Western Australia, during June 1952. The fisherman credited with finding the shell is known only as Angelo.

It should be noted that no type locality was established for the species in Gaskoin's original description; its habitat is cited as "unknown". However, the label on the holotype indicates "New Holland" as its source. New Holland is the old name for Australia; because such a designation is too vague to have much meaning as a locality, it becomes important now, based on the accurate information accompanying the second specimen, to establish Albany Bay as a restricted locality for the species. I therefore designate Albany Bay, Western Australia (34° 57' South Lat., 117° 58' East Long.) as the type locality for *Cypraea marginata* Gaskoin, 1848.

Acknowledgment

I wish to extend gratitude to my wife Jean Cate for the devoted help she has given me in the preparation of this paper, and sincere appreciation to Dr. Rudolf Stohler for providing important source material. The photographs are by Lowell Weymouth.

{Word was received by the author on October 25, 1960, that a third specimen of *Cypraea marginata* had been found. It was taken alive in a craypot in 120 feet off the Houtman Abrolhos Islands, Western Australia. Color photographs of this shell leave no doubt that it is indeed the third known specimen of this rare species. — from a personal communication to the Editor.}

Literature Cited

- Allan, Joyce
1956. Cowry shells of world seas. Melbourne, pp. 1-170.
- Gaskoin, J. S.
1848. Description of new species of the genus *Cypraea*. Proc. Zool. Soc. Lond., pp. 90-91.
- Hidalgo, J. G.
1906. Monog. de las esp. viv. del género. Madrid, pp. 1-598.
- Schilder, F. A.
1930. Remarks on type specimens of some recent Cypraeidae. Proc. Mal. Soc. Lond., vol. 19, pt. 1, p. 49.
- Schilder, F. A. and M. Schilder
1938. Prodrôme of a monograph on living Cypraeidae. Proc. Mal. Soc. Lond., vol. 23, pt. 3, pp. 119-231.
- Tryon, George W., Jr.
1885. Manual of conchology, vol. 7: Monograph of the family Cypraeidae, pp. 153-228.



Notes & News

High-Lights of a Collecting Trip

by

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In late August, 1960, I had the privilege of a four-day trip through the Gulf of California--two days with the Ariel Expedition (a group of Southern Californian collectors in a chartered Mexican trawler), crossing the Gulf from Guaymas to La Paz, and two days at La Paz with an expedition sponsored by the Belvedere Scientific Fund of San Francisco. Each of the two segments of the trip was climaxed by a special find.

The first find was a valve, among some about-to-be-discarded rubble, of an *Anatina*, s. s., presumably *A. anatina* (Spengler). This is a species about which there has been disagreement among authors. When I was preparing "Sea Shells of Tropical West America" I did not (and have not yet had) opportunity to consult the original description by Spengler, and I simply accepted the synonymy and range given by Dall in his review of American *Macridae* (1894). Whether Spengler in describing his *Macra anatina* in 1802 cited a locality is doubtful. Schumacher, proposing a genus *Anatina* for it in 1817, renamed the species *A. pellucida*, to avoid tautonymy. Wood in 1828 figured a specimen said to be from Peru under the name *Macra cyprinus*. According to Wilkins (Bull. Brit. Mus. [Nat. Hist.], Historical Series, vol. 1, no. 4, p. 165, 1957), Conrad as early as 1831 synonymized this with *M. lineata* (Say), from the Caribbean, and Wilkins, who refigured Woods' holotype, concurred in this correction of locality. Reeve, who had figured the same specimen in the 1850's, merely said, "Hab. -- ?" Dall's decision that the species is West Mexican probably was based on specimens at the U. S. National Museum, but I have not found any explicit statement to that effect. At any rate, it is confirmed by the Ariel Expedition material, in which one complete valve and some fragments were found. They match the Reeve and Wilkins figures well. The shell is proportionately longer and more sloping anteriorly than that of *A. lineata* (Say). None of the fragments would seem to be as large as Woods'

holotype, however. Two localities are represented.-- off Guaymas, Sonora, and off Carmen Island, Gulf of California, in depths of 15 to 25 fathoms. For the time being we must assume that the synonymy of *Macra cyprinus* with *M. anatina* was properly established at some time in the past, and so we record this new find as *Anatina anatina* (Spengler). It is perhaps not impossible that Spengler's description was based upon the identical specimen that Woods used. According to Wilkins, this shell was purchased by Mr. Cracherode (for whom our black abalone, *Haliotis cracherodii* was named) in 1797. As he was a man noted for cooperativeness in letting others study his material, could not Spengler have had access to this specimen when preparing his 1802 paper on *Macra*? Woods' shell is now in the British Museum, in fairly good condition despite its having been blasted from the tablet on which it was glued when a World War II bomb fell near the Museum. How so rare and fragile a shell could have been taken in the Gulf at that early date remains an enigma.

The second cause for personal elation was the finding of live specimens of the bivalved gastropod, *Berthelinia*, precisely where it had been predicted to occur. On Espiritu Santo Island, about 20 miles northeast of La Paz, we found it on fronds of a green alga, *Caulerpa*. The largest of the 34 specimens taken there came from the algae growing near rocks. On a later trip, Mr. Allyn G. Smith found more than 50 additional specimens at another locality nearer La Paz. These were on a different species of *Caulerpa* and averaged somewhat larger in size. The question of whether this Gulf species is really "*Scintilla*" *chloris* Dall (the type locality of which is Magdalena Bay) is yet unsettled. The latter is definitely a bivalved gastropod, however, for a syntype specimen at the California Academy of Sciences reveals the central muscle scar that Dall overlooked or did not recognize as a scar.

Taxonomic Revision of *Monadenia fidelis baxteriana* TALMADGE

by

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In 1954, the writer described as a geographical race the *Monadenia fidelis baxteriana* Tal-

madge (*Nautilus*, 68 (2), October 1954). This subspecies was based upon a series of specimens, collected by Mr. Ray Baxter, on Sister Rock, an islet off the southern Oregon coast. Until 1960 the original lot was the only known series of this race. The holotype had been deposited in the California Academy of Sciences in San Francisco, California.

Early in 1960, Mr. Munroe Walton, while gathering topotypes of the various genera and species of the land mollusks, obtained a very fine series of *Monadenia fidelis baxteriana*, not only from the islet, but also from the opposite mainland. A careful examination of this larger series has caused me to revise my diagnosis as to the status of this race.

Evidence, based on the additional specimens, now indicates that this "race" is only part of an ecological cline, blending in with adjacent mainland populations. The specimens from both the islet and the opposite headland are dwarfed, some more so than others. Specimens collected adjacent to this rather small area are more or less the same as the major mainland race, the *Monadenia fidelis beryllica* Chace (*Nautilus*, 48, 1935). As noted by all collectors who have worked the genus, populations vary from locality to locality, which makes a typical species extremely difficult to describe.

It is now obvious that this dwarfed population is part of an ecological cline rather than the usual geographical race. That there is definite contact between the more or less normal populations both to the north and south is indicated by some specimens being fully as large as the adjacent populations. That at least a partial separation exists is indicated by the large number of dwarfed shells. As this cline inhabits an ecological condition that is more or less unfavorable to the genus, the dwarfing could be considered a normal consequence. As the islet is rather close to shore, probably the geographical isolation has not existed for a long enough period in geological time to complete the evolution into a distinct subspecies.

Therefore, I feel at this time that it is best to place *Monadenia fidelis baxteriana* in the synonymy of *M. f. beryllica*, utilizing the name, if desired, to refer to the members of this rather localized dwarfed population.



Note on the Bivalved Gastropod *Berthelinia limax* (KAWAGUTI & BABA, 1959)

by

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On 21 August 1960 Dr. Siro Kawaguti, Professor of Zoology, Department of Biology, Okayama University, Japan, flew from Tokyo to San Francisco with living examples of his new bivalved gastropod *Berthelinia limax* and a liberal supply of its green food alga *Caulerpa okamura*. On arrival early in the morning of 22 August, Dr. Kawaguti was met by a vehicle from the Steinhart Aquarium of the California Academy of Sciences and taken to the Aquarium for the proper handling of his specimens, which he brought over in small round plastic containers in his brief case.

Shortly after arrival at the Aquarium arrangements were made to transfer the specimens to open, wide-mouthed glass jars of quart size along with a small amount of the food alga in each jar. It seemed probable, from temperature tolerances in the Okayama University laboratory, where Dr. Kawaguti had been eminently successful in raising specimens of *Berthelinia*, that clean salt water from the Aquarium's normal salt system (60-65° F. range) would be satisfactory. Therefore, the Japan Sea water was changed gradually to Pacific Ocean water so as to inhibit the possibility of undue shock in the transfer.

Dr. Kawaguti's living specimens were of several sizes (ages) and included one lot of *Caulerpa* with egg masses. After transfer, Jar #1 contained two adult animals, a third being added on discovery in the surplus lot of *Caulerpa* on 8 September. On 24 August two of the adults were observed in copulating position but whether egg masses were laid later could not be determined with certainty. One of the adults died on or about 20 September; another, on 28 September; and the third (the largest of the three) on 29 September.

In Jar #2 one half-grown specimen was observed on 8 September and one more of like size on 12 September. On 7 October both were still alive and active but on 10 October one died, followed by the other on 12 October.

Jar #3 contained *Caulerpa* with egg masses. At least one and possibly more of these hatched about 25 August and the next day Dr. Kawaguti observed them alive. Under the microscope

the thin, transparent, colorless, spiral shell of the nuclear stage could be seen along with the active animal. The operculum was observed attached to the foot. These newly hatched veligers evidently did not survive more than a day or so. Finally, the detritus at the bottom of the jar was filtered and over 100 of the minute nuclear spiral shells were recovered. These were mounted in slides using the technique for mounting foraminifera.

The ability to keep these small bivalved gastropods alive from 22 August to 12 October (52 days) in a different type of sea water seems worthy of record even though Dr. Kawaguti stated he had raised them through five generations in his laboratory. Obviously, these animals must have considerable tolerance to varying conditions of temperature and sea-water content.

Following Dr. Kawaguti's instructions, the jars were placed in full light during the day but away from direct sunlight. As portions of the *Caulerpa* died and became colorless, they were removed. Water was changed every three or four days, gradually by decanting and re-filling with new normal salt water from the Aquarium. No attempt was made to aerate the water in the jars or to oxygenate it. Although all specimens of *B. limax* finally died, a fair amount of the Japanese *Caulerpa* is still in fairly good condition at this writing (29 October, 1960).

On their arrival and for a considerable time afterward the living animals were active and continued to feed on the alga. Occasionally, one would crawl up the side of a jar and across the water at the top, clinging to the meniscus. On two or three occasions an animal would drop down from the meniscus and hang by a thread of mucus a half inch to an inch long, finally dropping down to a branch of the alga or to the bottom of the jar. The bright green color of the animal and shell maintained for many days. The round adductor muscle scar was seen easily through the transparent shell. When fresh and active the animals are difficult to see, especially the smaller ones, as they blend so perfectly into their normal habitat. Toward the end of the experiment, however, the shells of living animals began to whiten and generally lose the brilliant gem-like green color. After death this green color was lost almost completely.



Notes on the Habitat of *Berthelinia* spec. nov. from the Vicinity of La Paz, Baja California, Mexico

by

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Living *Berthelinia* was first discovered on 3 August, 1960, at about an eight-foot depth close to shore among large blocks of lava broken away from the adjacent lava wall at the north end of the fine sand beach of Bahia Candelero, Isla Espiritu Santo. A small loose roll of a feathery type of green alga (*Caulerpa* sp. ?) was brought up from the bottom by Sra. Mary Lou Adcock, which on careful search produced several small living specimens. Because this type of alga grows in great quantity in the sand and on dead coral chunks of the Bay, and was not at all prevalent in the rocky terrain, operations were transferred to the sandy area, a move of not more than 100 yards from the point of discovery. Large masses of *Caulerpa* were brought up from five to eight feet of water and placed in a large plastic bucket. Search of this produced more living specimens, along with a few living specimens of the sacoglossan *Oxynoe*. Temperature of the water was 82-84° F., with air temperature about the same.

Some of the living *Berthelinia* were placed in a plastic gallon-sized thermos jug along with a mass of the *Caulerpa* for transportation to San Francisco by plane the following day. Additional masses of the *Caulerpa* were thrown into buckets for transportation to San Francisco to permit later search for more specimens.

Unfortunately, the specimens of *Berthelinia* and *Oxynoe* did not survive. The *Caulerpa* was thickly inhabited by a small species of sea anemone which died also. Upon later careful sorting, the total of living specimens of *Berthelinia* found was brought up to nearly 40. The *Caulerpa* was inhabited also by quantities of minute mollusks, mostly gastropods with some pelecypods; occasional nudibranch egg masses were also noted. These were shaken out and preserved so as to obtain as complete a sample of the fauna as possible.

Opportunity was afforded to try for living *Berthelinia* again on 4 October. This time operations centered in the vicinity of Bahia Puerta Ballandra, on the mainland of the peninsula north of La Paz. The sand of this bay did not

have the masses of the feathery type of Caulerpa similar to those in Bahia Candelero, on Isla Espiritu Santo. However, small patches of it were growing on the volcanic rocks in quite shallow water adjacent to the north end of the sand beach. This Caulerpa was clean of the troublesome small anemone but careful search produced no Berthelinia. In the same general area, however, small patches of a different species of Caulerpa occurred, growing at the sides and between the lava boulders. This was a "bunch-grape" type, quite similar in its dark blue-green color and general characters to the Japanese Caulerpa okamurai. A major difference, however, was the flat, circular ends occurring in many but not all of the terminal branches of this alga. Berthelinia was discovered in this alga in some quantity and in size from juveniles to at least one presumed adult specimen with a shell length of 8.45 mm. Water temperature at this location was 82-83° F., with air temperature 84° F. It is worthy of note that our specimens were found under exactly the same conditions described for bivalved gastropods collected alive by Kawaguti in Japan and by Burn in Victoria, Australia.

A quantity of the alga from Bahia Puerto Ballandra was also brought home in a canvas bucket and search of this brought the number of specimens collected in this bay to about 50. The alga also produced a number of juvenile Oxynoe and several specimens of a grayish-colored nudibranch an inch or so in length.

The living specimens of Berthelinia and Oxynoe were brought aboard the boat and close-up photographs taken with an Exacta camera fitted with rings and using electronic flash. This proved to be somewhat difficult under conditions that had to be improvised, but mainly because the animals of both species were extremely active, crawling over each other and continually getting out of focus and upsetting the composition of the picture.

Although the same attempt was made to bring both species back alive for laboratory observation, this again proved unsuccessful, due perhaps to putting too much Caulerpa in the plastic thermos in relation to the quantity of water. It is reasonably certain, if this situation is corrected, that it will be possible to maintain live specimens of this Berthelinia in the laboratory, possibly by using an injection of oxygen during transportation similar to the technique followed in shipping small tropical fish by air. Such a procedure will be tried with the next opportunity to collect Berthelinia alive and transport it.

Perhaps it should be mentioned that small amounts of a type of Caulerpa, similar to, but smaller and lighter green in color, than the species from Bahia Puerto Ballandra, was found among masses of the feathery type collected in Bahia Candelero. It is not certain whether Berthelinia lives on this species normally in preference to the common species of the feathery type. Certainly this opisthobranch mollusk is not at all common on the latter type and specimens collected are quite small in size.

Samples of the types of Caulerpa collected in the La Paz region have been submitted for identification to Dr. George Papenfuss, Botany Department, University of California.

California State Regulations on Collecting Abalone

by

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In view of Keith Cox's splendid paper on abalone, reviewed in this issue, conchologists and collectors should be familiar with the requirements for taking them legally. The California law and the regulations of the State Department of Fish and Game establish seasons, minimum sizes and bag limits for the taking of abalone for sport (non-commercial) purposes. Under present sportfishing regulations the minimum legal sizes are as follows; red, 7; green, 6½; pink, 6; black, 5; and all other species, 6 inches in greatest shell diameter. Open season is March 16 to January 14. Limit is five abalones in combination of all species. "Fishing" hours are from one-half hour before sunrise to one-half hour after sunset. Special requirements include (1) carrying an accurate measuring device; (2) abalones of less than minimum size, if detached, must be replaced without delay on their original locations with the shell uppermost; (3) legal-sized abalones must be brought ashore above high water mark attached to their shells and alive; (4) no transportation or possession of abalones not in their shells, except when being prepared for immediate consumption; (5) no device longer than 36 inches, commonly called an abalone iron, can be used; (6) SCUBA divers cannot take abalones in California north of Yankee Point, Monterey County; and (7) last and by no means least is the pos-

session of a regular fishing license (\$3. - for residents). Small numbers of undersized abalones of all species may be taken by collectors only under a special Scientific Collector's Permit issued by the State Department of Fish and Game (cost \$5.-) generally only to persons affiliated with educational or scientific institutions.

The regulations apply to the taking of abalones alive. Presumably, dead shells washed up on the beach or elsewhere may be collected with impunity but even under these conditions it may be difficult to convince some game wardens that good undersized fresh shells were really "dead" when picked up.

About the Supplement

It is with great regret that we must announce that due to sudden ill health it will not be possible for Miss Steinberg to complete the key to the West Coast Opisthobranchs, nor the glossary. However, we shall proceed with the publication of the portion by Professor Marcus. The key and glossary will be published as soon as possible and will be mailed to those who have purchased the supplement, without additional charge.

— Editor.

New Western Shell Clubs

In the NORTHWEST —

The Northwest Shell Club held an organizational meeting on September 18, 1960, in Seattle, Washington, in the home of Mr. W. Jackson Sallee. The second organizational meeting to approve the charter was held on November 13, 1960, at Point Defiance Aquarium in Tacoma, Washington. At that time there was also a discussion of local dredging.

At the first meeting the following officers were elected: President — Tom Rice, Poulsbo; Vice-President — Dr. Phil Spicer, Centralia; Secretary — Miss Joan Shields, Seattle.

The Club was organized to promote the study of malacology. Any collector interested in this goal is invited to become a member of this new Club. Dues are \$2. per year for full members, \$1. for junior members. Residents of the Pa-

cific Northwest are especially urged to join.

Further information will be furnished upon request by:

Tom Rice, Route 2, Box 483, Poulsbo, Wash. or

Miss Joan Shields, 418 Loretta Pl. # 509 Seattle 2, Washington.

In the SOUTHWEST —

An organizational meeting for a San Diego Shell Club was held in the home of Mrs. Charles Harsh on November 6, 1960. Mr. R. O. Stotter of 1046 Ocean, Imperial Beach, California, will serve as president for the remainder of the year 1960. Mr. William Naylor of 3616 Curlew Street, San Diego, and Mrs. Ray Webb of 730 Date Avenue, Chula Vista, will similarly serve as Vice-President and Secretary, respectively. Information concerning meetings and plans for the future can be provided by these officers.

Methods & Techniques

A Simple Device for Sorting Microscopical Shells from Sand Samples

by

GEORGE L. HERSH

Department of Zoology,
University of California, Berkeley 4, California
(With 1 Textfigure)

The task of separating minute shells from sand can be speeded by using a mechanical device to move a thin ribbon of sand under the field of a binocular dissecting microscope. A narrow endless belt, mounted on rollers and hand driven by a wheel connected to one of the roller axles, moves the sand. A hopper, whose exit is slightly narrower than the microscope field is mounted over the centerline of the belt just far enough from the curve of the roller so that the belt beneath the hopper opening is flat. The clearance between the hopper and the belt is adjusted to suit the grain size of the sample by turning a threaded post which controls the

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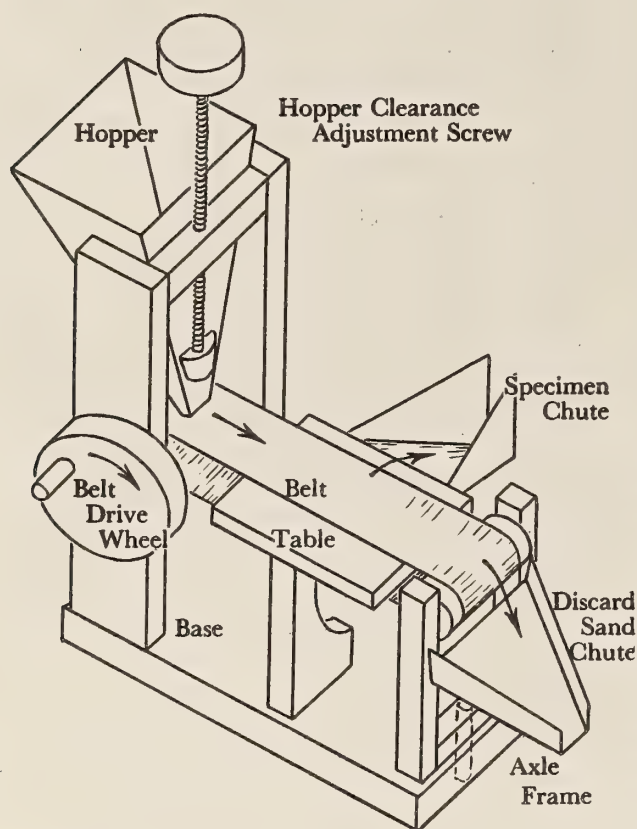
To Describe?

- or NOT To Describe?

by

R. STOHLER

Department of Zoology,
University of California, Berkeley 4, California



movement of the hopper on a pair of vertical slides. Two chutes lead from the belt. One, cemented to a table which supports the belt under the microscope objective, catches shells pushed from the belt by the observer. The other, fitted with a small brush, removes the residual sand from the belt. Provision must be made for removing the axles to change belts and for sliding one of the axle frames along the base to tighten the belt. The walls of the hopper and floors of the chutes should be steep enough to ensure good gravity flow of dry sand. The walls of the chutes should be high enough to prevent individual particles from bouncing out. This device is not intended to be used to sort large shells from fine sand, but rather as an aid to sorting after sieving has produced samples of roughly similar grain size.



The problem whether or not to describe a new species or subspecies, or, for that matter, any other taxon, must be decided by the individual investigator. While the ideal situation would be to await a large amount of material, including living animals, and the results of histological and, possibly, even cytological investigations, as well as breeding experiments, it is obvious that such ideal conditions can rarely, if ever, be obtained. The decision must then be made on the basis of justification. By that is meant: with material available, is the establishment of the new taxon justified? Sometimes if the material available is very scanty, such as a single shell, this question may be answered in the affirmative only under special circumstances.

While there is no supreme authority to whom one may appeal for a binding decision each author might be guided by the following considerations:

A. Is the specimen markedly different from any of the known and probably closely related forms?

B. Was the specimen obtained from a geographically well defined area and are no similar "species" known from that same area?

C. Is there great likelihood that careful search in the "new" area will bring to light additional specimens, but such a search is extremely difficult or almost impossible?

If these three conditions are met, it would seem probable that no describer will be criticized for hasty action. Unfortunately, however, there are certain pitfalls included in the three conditions enumerated.

In condition A the words "markedly different" may be interpreted vastly differently by different students. The more experienced an investigator becomes the more readily will he detect differences that are overlooked by others, and he may be inclined to consider these differences "marked" while a less experienced student

might not even recognize any difference at all. It would seem, therefore, that room for subjectivity is available here and thus there is also room for criticism. Perhaps the more experienced taxonomist might be induced to hold a tight rein on his tendency to "describe" by remembering how much confusion has resulted from the uninhibited "splitting" by some of our past conchologists.

Condition B is fraught with like difficulties. It would be most desirable to define exactly what a "geographically well defined area" is. Also, it would be important to establish how certainly we know that no similar species do occur there. The first problem is not too difficult in many instances. A rocky plateau rising from great depths in the middle of the ocean to within a few feet of the surface could certainly be considered a "well defined area." On such isolated spots it might be expected that endemic forms may have arisen. Similarly, valleys separated from each other by steep and high mountain ridges could be considered well defined areas. The second problem is not as easily solved. No doubt, the describer of the "new" entity can be absolutely certain that he does not know of any other similar species from that area. But if he is satisfied with his knowledge alone, he can certainly be considered an irresponsible individual. The careful worker would most assuredly endeavor to search the literature as well as representative museum and private collections for anything that might, even remotely, resemble his "new" find. Only after a fairly exhaustive search has been unsuccessful should the potential author consider that "no similar species" occur in the particular area.

Condition C is, if closely analysed, a two-edged sword. Who is to decide whether a careful further search is extremely difficult or impossible? What may be impossible for a particular individual may be relatively easy for an organization. For example, to explore a sub-surface rockplateau as described above would certainly be impossible for any one individual. But some institution equipped for oceanographic research might find it relatively easy to send a boat, properly equipped and staffed, to make such a search.

Assuming now that our hypothetical author has very carefully and conscientiously assessed these three conditions and found that he must answer all in the affirmative (note that we say must, not can), what should be his next steps?

The various steps that might be followed un-

der ideal conditions, may be listed thus:

- A. Selection
- B. Naming
- C. Description
- D. Illustration
- E. Disposition of material
- F. Publication.

In the following paragraphs we will discuss these steps in order, it being understood that after each of the listed steps there is always the same unlisted step to be taken, the most difficult one — self-criticism, i. e. critical reappraisal of each step after it has been taken.

A. SELECTION

This step is simplified if but a single specimen is available. In the case where several specimens have been obtained, the process of selection is very important. It is necessary to decide what one wishes to consider as the "typical" representative of the new taxon. The choice should be settled on a single specimen which is then to be designated as the holotype. Since modern biological experience has shown that often very similar appearing organisms are reproductively isolated — which means that members of these similar species cannot be bred with one another or, at best, can only produce a sterile hybrid generation — and thus must be assigned to different species, it will avoid possible future confusion and future difficulties if one particular individual is selected and designated as the holotype. Any other member of the original type lot may eventually be found to belong to some entirely different species, but the original selection fixes at least the species of the holotype forever.

If several specimens are available, they should certainly be used to study and describe the variability observable in that group. It is generally accepted that a species may include a great number of individual variants — just compare the members of your own kinship to get an idea how variable the human species is, for an example — and that it is utter nonsense to name each variant. All specimens obtained from the same locality as the holotype (that locality being the type locality) and used for describing the range of variation, are then designated as paratypes. Still other specimens, obviously of the "new" species, but obtained from another than the type locality, may also be used for describing the range of variation but these specimens should not be designated as paratypes (although many reputable investigators do so); they should be called hypotypes.

B. NAMING

Frequently a new taxon is named to honor some particular person, be it the original collector of the new taxon, the sponsor of an expedition, or just a good friend. While there can be little objection to this procedure, it seems more desirable, however, to select a name which conveys some important information. Frequently the name of the locality where the specimen was collected will be most suitable, but especially so in the case of subspecies which are geographically isolated. In other instances, some striking feature of the ecological niche in which the specimen was found may lend itself for the name to be coined. It is important, however, that the name chosen be formed correctly and sound pleasing to the ear. The following books may prove helpful:

A. L. Melander. 1940. Source book of biological terms. The College of the City of New York.

R. S. Woods. 1944. The naturalist's lexicon. Abbey Garden Press, Pasadena.

E. C. Jaeger. 1959. A source book of biological names and terms. Charles C. Thomas. (third edition).

It is important to make certain that the name selected has not been used previously in the same genus, as otherwise it will be a dead-born synonym! In a future issue of the *Veliger* we will discuss some of the necessary steps in ascertaining that the name is not preoccupied.

C. DESCRIPTION

In describing a new taxon the greatest care should be exercised to avoid ambiguous statements; nor should terms be used such as "bigger than", "darker than", etc. The description should be complete and accurate and understandable without reference to any other specimen, such as a closely related species; nor should the author be concerned about making the description very short. To be sure, it should be brief, but only as brief as it possibly can be yet still cover every aspect, no matter how minute. Although ample illustrations should be used, yet the description in words should not omit any point even though the illustration will bring that particular feature out much more clearly.

When we speak here of the description, we are actually referring to something a little more complex than would appear at first glance. The complete description should consist of the minute description of the holotype, followed by

a description of the variations, no matter how slight, observed in the paratypes and, possibly, other specimens of the same new taxon. In the description, attention should also be paid to differences that may exist between members of the two sexes. It has happened that males and females of the same species were actually described as two different species and only later observation of the mating of these "different species" gave the clue to the fact that but a single species was involved. Of course, if only one specimen is available, sex differences cannot be observed; also, in many cases there are no differences noticeable aside from the reproductive organs. Yet a thorough description would in the latter case, no doubt, include a statement to that effect.

Occasionally, the type specimen (or specimens) may exhibit various abnormalities, flaws, cracks in the shell or other hard parts, etc. These should be noted as flaws, if the describer recognizes them as flaws; he should still include them in the description, even though he does recognize them as flaws.

To the description then should be added a discussion, the diagnosis, in which the new entity is compared with its closest related forms, particular attention being paid to the differences which separate the new from the old. The importance of this phase cannot be stressed enough, since often it is possible to obtain a correct mental picture of the new form by relating it to a relatively well known entity.

Nothing is more subjective, perhaps, than the description of colors. Yet often the coloring of a specimen, particularly in the living state, may be an important diagnostic feature. To avoid the pitfalls of subjective color designations, there are available standardized color "dictionaries" to which the author should refer. The following are among the better known:

A. Maerz & M. Rea Paul. 1950. A dictionary of color. McGraw-Hill, vii, 208 pp., 56 color plates (second edition).

Munsell Color Company, Inc. 1929-1942. "Munsell book of color." 2 pp., 42 color plates.

Séguy, Eugène. 1936. Code universel des couleurs. Paris. lxviii and atlas, 55 color plates.

It is desirable to add a diagnostic key at the end of the description, in which all related species (and subspecies, as the case may be) are clearly differentiated from each other and make it possible even for a relatively new student of the group to identify a given species with certainty.

Finally, there is one more important fact that should never be omitted from the original description: the type locality. By this is meant the exact geographical location where the type material was collected. Often it may be necessary to refer to the field notes of the original collector and that is the reason why any one who collects specimens that might be used for taxonomic or systematic studies should be urged, or rather, required to keep very careful field notes. In describing the type locality ecological data should also be included. When a type locality is listed by some local, vernacular name it may be very obscure to the student who is not familiar with the area. But even officially adopted designations may, in the course of a few decades, become obscure because of political changes of one sort or another. It is obviously advisable that the type locality be designated not only by the best available official name but also by geographical longitude and latitude to the nearest minute. Such localities as "Pacific Ocean" are so clearly inadequate that it seems ridiculous even to mention this example. Yet many less obviously poor locality designations are encountered much too frequently.

D. ILLUSTRATION

It is a truism that a good picture is worth a thousand words — often more! But this is true only if the illustration is good. Excellent results may be obtained with photography. But as there are many difficulties of a technical nature attendant upon this method, it is often best and easiest to employ the services of a photographer specializing in this field. Line drawings are also desirable as the skilled artist can emphasize the important points without actually falsifying the whole picture. With modern methods of reproduction and their relatively low cost, it is inexcusable to publish a description without adequate illustration and it may be hoped that the time is not too far off when a description will not be considered valid if not accompanied by clear illustrations.

E. DISPOSITION OF THE TYPE SPECIMENS

It seems unnecessary to stress the importance of proper and perpetual care of the type material, especially of the holotype. Private collections have proven time and again to be the worst possible repositories for such irreplaceable and truly unique material. Next in line of poor repositories are general collections of colleges and universities. Private museums,

if properly administered, may be less undesirable than the other two places mentioned. Only a public museum, preferably one housed in earthquake- and fire-proof buildings, can be considered a safe place. If an author desires to keep some of his paratypes on hand — during his lifetime — he should make provisions in his last will to insure the transmittal of this valuable material to a public museum of his choice.

If type material is plentiful, i. e., if there are several to many paratypes in addition to the holotype, then it seems considerate to send some paratypes to widely separated museums so that other workers may more easily have access to such material, than if it were all deposited in one place. Whatever disposition of the type material is made should be added to the original description. Museum Numbers should also be listed.

Perhaps it is not amiss to add a few words about the importance of the disposition of the type material. The holotype specimen is in all cases to be considered as the highest authority whenever any question arises about other specimens. By direct comparison of a questionable specimen with the type specimen any doubt can be resolved. If the type specimen has been lost or destroyed then confusion may well be the result, especially if no paratypes (or others) exist. If syn-, co-, or para- types to exist then a qualified investigator may select, if desirable, one particular specimen to become the norm for all future time.

F. PUBLICATION

The last step in the entire procedure requires that some care be exercised. It is necessary that the date when the publication is distributed be known since the laws of priority may enter into the picture. All typographical errors should be corrected, but especially in the name of the described taxon, as a misspelling — unless it is very obviously so — will have to be carried on forever after.

In conclusion we would strongly urge the author who, for the first time, is confronted with the important question which we chose as the title of this article, to study very carefully the following two books:

Edward T. Schenk & John H. McMasters. Procedure in taxonomy. 1959. Stanford University Press (third edition, second printing).

Ernst Mayr, E. Gorton Linsley, & Robert L. Usinger. Methods and principles of systematic zoology. 1953. McGraw-Hill Book Company.

Books-Periodicals-Pamphlets

{Editor's Note: Beginning with this issue, the authors of the major reviews will be identified by the initials of their names. The majority of reviews will be contributed by members of the editorial board, and thus their initials can easily be checked against our list on the inside front cover. Other regular contributors are: JQB = John Q. Burch; ECA = Edwin C. Allison; CRS = Charles R. Stasek.}

GASTROPODA EUTHYNEURA

by A. Zilch

in Handbuch der Paläozoologie, Band VI, Teil 2, Lief. 1-3, 1959-60, 600 pp., 2111 figs. (Lief. 4 in press, with 200 pp. and 400 figs.) Published by Gebrüder Borntraeger, Berlin. 84 DM per part (about \$22).

This is a continuation of a seven-part work on *Gastropoda* by W. Wenz, 1938-1944, of which few copies reached the United States, due to war conditions. Complete sets of Teil 1 are, in fact, almost unobtainable, for the printer's stock of one part was destroyed by fire during a bombing raid. Wenz' review of the *Gastropoda* was based on the classification of Thiele ("Handbuch der Systematischen Weichtierkunde", 1931-35) but was much more extensive because he included also the fossil forms. Wenz died before completing his work, as he had published only the Streptoneuran section. Zilch's continuation, like the original of Wenz, is a costly publication, and probably few libraries (not to mention individuals) will feel justified in paying \$88 for a single 800-page volume, although this is a very important — one might almost say indispensable — reference work in its field.

The arrangement of the text is systematic, with a comprehensive coverage of genera and synonyms. Half-tone text figures are given for each unit that is recognized as valid. The text is in German, and descriptions are fairly detailed, averaging much longer than in the American "Treatise of Invertebrate Paleontology". Zilch follows the format developed by Wenz, with citation of type species for all valid genera. Lieferung 1 covers Cephalaspidea, Nudibranchiata, Basommatophora, and a part of Stylommatophora (=Pulmonata); Lieferungen 2 and 3 continue the Pulmonates. Presumably Lieferung 4 will complete the systematic portion and contain an index to the four parts.

— MK

TREATISE OF INVERTEBRATE PALEONTOLOGY

Edited by R. C. Moore

Part 1, Mollusca I, by J. Brookes Knight, L. R. Cox, A. Myra Keen, A. G. Smith, R. L. Batten, E. L. Yochelson, N. H. Ludbrook, Robert Robertson, C. M. Yonge, and R. C. Moore. 351 pp., 216 text plates. August 1960. Published by the Geological Society of America and the University of Kansas. \$7.50.

When the "Treatise" is complete, there will be 23 volumes, lettered from A (Introduction) to W (Miscellanea). They are not, however, being published in alphabetical order. Volumes I through N are reserved for Mollusca, of which up to now only L (ammonoid cephalopods) has appeared. The new Volume I covers Amphineura, Scaphopoda, and Order Archaeogastropoda of the Gastropoda (with a supplement on Paleozoic groups of other gastropod orders); Volume J will conclude Gastropoda. The present volume opens with a masterly essay by Dr. C. M. Yonge on "General Characters of Mollusca", comprising some 34 pages; this, with a similar 85-page essay by Dr. L. R. Cox ("General Characteristics of Gastropoda") makes a readable as well as a sound introduction to the study of mollusks. The three lesser orders of Mollusca are interpolated between these two chapters. Scaphopoda (4 pages) are reviewed by Dr. Nell Ludbrook, and Amphineura are summarized by Allyn G. Smith in what is probably the most thorough-going treatment that the group has received during the present century. After a concise introduction on morphology of about eight pages, he gives some 30 pages to a review of genera. The Monoplacophora are treated as a separate Class of Mollusca, mainly Paleozoic but culminating in the Recent *Neopilina*. The remainder of the volume is devoted to a review of the Gastropoda, beginning with the primitive groups like Pleurotomariacea and continuing through Neritacea. Systematic descriptions for Paleozoic genera are by Knight, Batten, and Yochelson; for Mesozoic genera by Cox; and for Cenozoic genera by Keen, assisted by Robertson on Phasianellidae.

Arrangement of the systematic part is complicated somewhat by the attempt to treat Paleozoic, Mesozoic, and Tertiary units in sequence. Text descriptions are brief, and illustrations are grouped compactly, though usually not far from the pertinent text. Illustrations are, in the main, line drawings, and practically all of them are of type species of genera. Most

of the genera and subgenera that are based on fossil forms are illustrated, but Recent groups are, understandably enough, not given as detailed treatment. However, type species and geographic and geologic ranges are given for all known units. Thus, the book should prove useful as a reference work to the neontologist as well as to the paleontologist. Considering its size and the number of illustrations (about a thousand separate figures), the price is agreeably low.

— RSt

OYSTERS

by C. M. Yonge

Collins, St. Jame's Place, London. Pp. 209, 31 black and white photographs and 72 text figures. 1960. 21s (about \$2.94).

Perhaps it is my enthusiasm for bivalved mollusks that led me to read this excellent book in a single night. Still it may be Professor Yonge's easy style of writing and his own enthusiasm that make the reading so enjoyable.

"Oysters" has included in it chapters on the anatomy, physiology, reproduction and development, ecology, and evolution of this group of bivalves. Although the author has by no means underestimated the understanding of the reader, he has presented factual, often complex, material in a way both literary and scientific.

Professor Yonge's views on the early hypothetical evolution of bivalves are very well presented in Chapter 1. But, as a criticism, the strength with which these views are put forth may lead the reader to believe that they comprise a factual account of this early evolution. In actuality they represent one of perhaps several reasonable lines of thought on this purely hypothetical subject. Also, as technical criticisms, the association of gills and palps of the generalized bivalve (fig. 1, C) does not exist in nature, and the labels of the "quick" and "catch" portions of the adductor muscle in Figure 15 are reversed (see fig. 41 which is correct). Minor faults such as these in no way affect the overall value of the book.

— CRS



SCAPHOPODES ET LAMELLIBRANCHES RÉCOLTÉS DANS L'OUEST AFRICAIN

by Maurice Nicklès

Atlantide-Report No. 3, Scientific Results of the Danish Expedition to the Coasts of tropical West Africa 1945-1946 (Danish Science Press, Ltd.: Copenhagen), pp. 93-237, figs. 1-41, 1955.

This paper is based upon a study of 13 species of Scaphopods and 201 species, subspecies, and varieties of pelecypods collected along the West Coast of Africa. Of the total (214), 24 species and one subspecies are described as new. The paper also contains records of occurrences, general distribution, references to the earlier literature, and comments. Excellent line drawings are used to illustrate 40 species and one variety.

An interesting record in this paper (p. 225) is that of *Periploma discus* Stearns. The West African shell cited under this name was not illustrated and whether or not it is identical with *P. discus*, a species originally described from "San Pedro, Long Beach, etc., Los Angeles County, California" may be open to question. However, the citation of this species in the east Atlantic fauna emphasizes the fact that similarity exists between some of the West African and West American mollusks as mentioned long ago by Carpenter and by Mörch.

— LGH

REVISION OF THE WORLD SPECIES OF APLYSIA (GASTROPODA, OPISTHOBRANCHIA)

by N. B. Eales, Department of Zoology,
University of Reading

Bull. British Mus. (Nat. Hist.), Zool.,
vol. 5, no. 10, January 1960, pp. 269-
404, text figs. 1-51.

This is a most welcome account of the sea-hares of the world, which brings the taxonomy up to date and gives complete discussions, together with line drawings, of the synonymy, distribution, examined material, and detailed characters of all recognized species. Particularly helpful are some practical notes that point out the basic characters used to describe and identify species, and instructions for anesthetization, killing, and fixation of specimens for the minimum of contraction desired in dissection. The genus is divided into six subgenera, one (*Phycophila*) with a single species being pelagic, the others presumably mostly occurring intertidally. A total of 30 species is recognized, with the following described from the

West Coast of North America: Aplysia (Pruvot-aplysia) parvula Guilding in Mörch, 1863, with a circumtropical distribution; A. (Neaplysia) californica Cooper, 1863, the largest of the genus with a maximum recorded weight of 5 lb. 12 oz.; A. (Varria) robertsi Pilsbry, 1895, from the West Coast of Mexico and Central America; A. (V.) dactylomela Rang, 1828, from Panama and elsewhere; A. (Aplysia) cedrosensis Bartsch & Rehder, 1939, from Cedros Island and San Bartolomé Bay, Lower California; A. (A.) juliana Quoy & Gaimard, 1832, from California, the Galapagos Islands, and Peru; A. (A.) vaccaria Winkler, 1955, from southern California. Described as new is Aplysia (Varria) rehderi, based on a single specimen from Monterey, California, in the United States National Museum. Although the discussion is complete and thorough on taxonomy, distribution, and morphological characters, there is little information on the life history of species or their ecology — a gap that will no doubt be filled, as time goes on, by closer observation. There is an excellent list of references at the end of the paper, together with a good index.

— AGS

THE ABALONE OF CALIFORNIA

by Keith W. Cox, Calif. Dept. of Fish and Game
California Fish and Game, vol. 46, no.
4, October 1960, pp. 381-406, figs. 1-9.

This is a carefully written, thorough account of the eight species of California Haliotis, based on the results of a legislatively-directed investigation by the California Department of Fish and Game. This study started in 1939 and was expanded in 1951, being first directed by the late Paul Bonnot and continued by Keith Cox. The purpose of the account is well stated by Mr. Cox in his introduction when he says:

"Since most of the laws and regulations governing the fishery are different for each species, proper identification is of the greatest importance for all concerned (because, he says) of the thousands of sportsmen who fish abalone, less than one percent know all of the species they take; and many engaged in commercial fishery are not familiar with all the abalone they encounter."

Cox' treatment goes a long way toward helping to dispel this lack of information. His notes on the life history of abalone, while brief, are well put and contain interesting ecological data,

some of it not published heretofore. In discussing each species, brief paragraphs are devoted to the distinguishing characters of the shell and the animal (particularly of the epipodium), its geographic distribution, habitat, commercial and other uses. These are supported by magnificent colored plates (figs. 2-9) of the inside and outside of a typical specimen of each species from photographs by Glen Bickford. Figure 1 is a drawing showing the important structures of the animal. A tabular key, by species, provides a comparison of principal characters for ease in identification.

Depth ranges in California given for the eight species are interesting and may be tabulated as follows:

Species	Maximum range (in feet)	Principal Concentration (in feet)
<u>rufescens</u> (red)	Near high tide mark to 540	20 to 50
<u>corrugata</u> (pink)	Intertidal to 180	20 to 80
<u>fulgens</u> (green)	Low tide to 60	10 to 20
<u>cracherodi</u> (black)	Near high tide to 20	Intertidal
<u>wallalensis</u> (flat)	Subtidal to 70	Not given
<u>kamtschatkana</u> (pinto)	Subtidal to 50	35 to 50
<u>sorenseni</u> (white)	15 to 150	80 to 100
<u>assimilis</u> (threaded)	10 to 120	70 to 100

Because this is such a useful and important account, one hesitates to call attention to a few technical points of concern, perhaps, only to malacologists and taxonomists. No mention is made of Haliotis ponderosa C. B. Adams nor of H. rufescens hattorii Bartsch, both probable synonyms of the red abalone, H. rufescens Swainson (p. 386). No published reference is known for "H. revea Bartsch" (p. 390), stated to be a synonym of H. fulgens. This specific name evidently refers to Delbert Reveia, a commercial diver who worked with Paul Bonnot. The placing of H. fulgens turveri as a synonym of H. fulgens seems proper. Use of the term "flat" for H. wallalensis (p. 394) is unfortunate. A better term, already used for this species, is "sunset abalone" to signalize the almost unequalled beauty of its nacreous interior. H. aulaea (misspelled "aulae" on p. 396) and H. smithsoni are both stated to be synonyms of H.

kamtschatkana. Based on geographic distribution there seems to be some evidence that these forms, described in 1940 by Bartsch, may be more closely related to H. assimilis.

Mr. Cox is to be congratulated for his informative and timely paper.

— AGS

{We are informed that reprints of this article will be available for a nominal price at:

Printing Division, Document Section
North 7th Street at Richards Boulevard
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— Ed.]

AUSTRALIAN BIVALVE GASTROPODS

by Robert Burn

Nature (London), vol. 187, no. 4731,
2 July 1960, pp. 44-46, text figs. 1-14.

Mr. Burn reports finding the sacoglossan opisthobranch Edenttellina typica Gatliff & Gabriel, 1911, alive for the first time (four specimens) at Torquay, Victoria, on the green alga Caulerpa scalpelliformis (R. Brn.) C. Ag. and describes the animal and shell in some detail. He changes the generic name to Berthelinia Crosse, an older genus described from the Eocene fauna of the Paris Basin. Comparison is made with a Queensland species, E. coralensis Hedley, the newly described Japanese species Tamanovalva limax Kawaguti & Baba, 1959, and with Scintilla? chloris Dall, from Magdalena Bay, Lower California. Burn regards these four bivalved gastropods all as lying within the known extremes of zoogeographical variation within a single species, Berthelinia typica, which, in the reviewer's opinion, seems a rather extreme view that needs to be verified. Described and figured also is Midorigai australis n.gen. and n. sp. based on seven living specimens from Torquay and Flinders, Victoria, collected in March and April, 1960. At Torquay this animal lives on the same species of green alga as B. typica, along with the oxynoid sacoglossan, Oxynoe viridis Pease. At Flinders the host algae are Caulerpa brownii (C. Ag.) Endl. and C. simpliciuscula (Turn.) C. Ag. Of interest is the fact that these small green bivalved gastropods all seem to live in similar ecological niches and only on species of green algae of the genus Caulerpa.

— AGS

THE FOSSIL HISTORY OF SOME NEW ZEALAND CALYPTRAEEIDAE (GASTROPODA)

by D. P. Boshier

New Zealand J. Geology and Geophysics, vol. 3, no. 3, August 1960, pp.
390-399, text figs. 1-3, table 3.

Two phyletic sequences of species of Sigapatella, distinguished by degrees of shell sculpture, are traced through New Zealand fossil records. Both appear to have evolved from Eocene forms of Sigapatella which, in turn, can be traced from the late Cretaceous calyptraeid Spirogalerus lamellaria Finlay and Marwick. The two lineages of Sigapatella Lesson are represented by the living S. supertes Fleming and by the other living sigapatelloids.

— ECA

THE LOWER ANIMALS, LIVING INVERTEBRATES OF THE WORLD

THE LOWER ANIMALS, LIVING INVERTEBRATES OF THE WORLD

by Ralph Buchsbaum and Lorus J. Milne
Doubleday, New York. 1960. \$12.50.

The book contains 315 illustrations including 144 in full color. There are a number of interesting color plates of mollusks, and the text is accurate and well written. It is a beautiful book and well worth placing on the bookshelf.

The senior author, Ralph Buchsbaum, is Professor of Zoology at the University of Pittsburgh and author of the widely used textbook Animals without Backbones. His wife is also a zoologist and has worked with him in researches in America, Europe, and Southeast Asia. Lorus J. Milne is Professor of Zoology at the University of New Hampshire, and his wife, Dr. Margery Milne, has worked with him in an investigation of the role of vision in invertebrates in North, Central, and South America, and in Africa. Together they have written many books.

Two outstanding teams of scientists have drawn on their rich experience for a fascinating review of the lower groups of the Animal Kingdom. Together, the text and figures form an unsurpassed introduction to the life of land and water, the creatures of beach drift, tidal pool and open sea, and the organisms of living tissue.

— JQB

HANDBOOK OF PALEONTOLOGY
FOR BEGINNERS AND AMATEURS

by Winifred Goldring

Paleontological Research Institution,
1960. 394 pp., 97 figs.

This book was originally published in 1929, and was written for the student who was approaching the field of paleontology with little or no background in zoology. The quality of the work caused it to be used as a textbook in introductory courses in schools and colleges. The result was that this handbook was out of print by 1935.

The revised edition has taken note of changes in names. In dealing with recent revision in classification complexities have been avoided as far as possible, and an attempt was made to avoid decisions on controversial matters.

While this is a scholarly work, it is written to be understood by the layman.

— JQB

PROCEEDINGS OF THE MALACOLOGICAL
SOCIETY OF LONDON

Vol. 34, Pt. 2, for August, 1960

Obituary notice for J. Brookes Knight, by Ellis Yochelson, pp. 55-59.

"Thoughts on the classification of the Bivalvia", L. R. Cox, pp. 60-88.

"*Petalifera habei*, a new species from Japan", Addendum, N. B. Eales, p. 112.

VENUS:

JAPANESE JOURNAL OF MALACOLOGY
Vol. 21, No. 1, for July, 1960

"On a new subgenus and a new species of *Fulgoraria* from Japan", S. Hayasi, pp. 1-4, 1 pl. (Includes a brief systematic review of this volutid group.)

"Notes on the species of Japanese shells described by A. A. Gould", T. Habe, pp. 10-31.

"Identification of the larva of *Saxostrea echinata* (Quoy & Gaimard)", Y. Tanaka, pp. 32-38, 2 pls.

"*Argonauta boettgeri* preys on *Cavolinia tridentata*", T. Okutani, pp. 39-40.

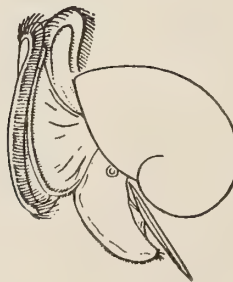
"Ecological observations on an aberrant lamellibranch, *Ehippodonta murakamii* Kuroda", K. Arakawa, pp. 50-60, 2 pls., 1 map.

"Some ecological accounts on *Scintilla vitrea* (Quoy & Gaimard)", K. Y. Arakawa, pp. 61-66, 1 pl.

"Miscellaneous notes on Mollusca", K. Y. Arakawa, pp. 66-78, 1 pl., 9 figs. (Notes on feeding and spawning of several marine forms, with good photographic illustrations, especially a series on *Charonia* eating a starfish.)

"Some observations on *Anadara* (s. s.) *amicula* (Yokoyama)", K. Tanaka, pp. 78-92.

"On the shell form of the Japanese fossil and Recent *Anadara granosa* (L.)", J. Nagasawa, pp. 92-96, 1 fig.



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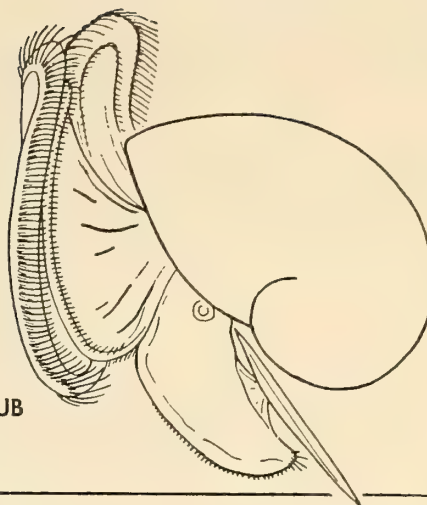
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A New Name for *Buccinum tenue* GRAY, 1839, preoccupied

by

JOSHUA L. BAILY, JR.

RESEARCH ASSOCIATE

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It is always a source of confusion when a name which has achieved common usage and is universally understood has to give way to a thoroughly unfamiliar one. In such cases the way is open for an appeal to the International Commission on Zoological Nomenclature, but sometimes even this course is not entirely practical. Such an instance is afforded by the well known *Buccinum tenue* Gray (Zool. Beechey's Voyage, p. 128, pl. 36, f. 19, 1839), which name is twice preoccupied.

The first use of this nomenclatorial combination was by Schröter (Wiedemann's Archiv Zool., v. 4, pt. 2, p. 76, 1805). The description is not very satisfactory because it is not accompanied by an illustration or by a reference to a previous publication. Further, there is no mention of a related species with which it might be compared, nor is its habitat given. We do not even know whether its placement in the genus *Buccinum* is correct or not. Yet the name cannot be considered a "nomen nudum" because the description is about half a page in length. It is not adequate to make an identification possible, but it is adequate to preclude the use of the name by later writers, and if Schröter's type material should ever turn up, his use of the name would be entitled to priority over the others.

The second use of the name was by Wood (Index Testac., Suppl., p. 12, pl. 4, f. 5). This well executed figure suffices to show that this species is not a *Buccinum* at all, but a *Cassis*. The first author to recognize its true generic affiliation seems to have been Kiener (Spéc. Gén. Iconogr. Coq. Viv., v. B, p. 17, pl. 8, f. 14, 1835). Kiener called it *Cassis massenae*, which appears to be the correct name by which it should be called.

The third use of the name was by Gray (loc. cit.), and it is quite a problem to select a name for it out of the many which have been cited in

its synonymy by later writers. The first of these potential synonyms is *Buccinum scalariforme* Beck (Naturh. Tidsskrift, v. 4, pt. 1, p. 89, 1842). Beck was not proposing a new name for an old species but was describing a new species. Tryon (Man. Conch., ser. 1, v. 3, p. 184, 1881) stated these two species had been synonymized but that he personally felt that it was more likely that Beck's species was a synonym of *Sipho kroyeri* Möller (Index Moll. Grönl., p. 15, 1842).

Then Stimpson, in a revision of the family Buccinidae, published in 1865, which I am unable to locate, allowed Gray's name to stand but placed in its synonymy *Buccinum tortuosum* Reeve (Conch. Icon., v. 3, *Buccinum*, pl. 14, f. 113, 1847) which, according to Stimpson, was based upon a deformed specimen.

And then Jeffreys (Ann. Mag. Nat. Hist., ser. 5, v. 6, p. 423, 1880) united in a single species *Buccinum tenue* Gray, *Buccinum tortuosum* Reeve, and *Buccinum ochotense* Middendorff (Beitrag. Malac. Rossica, pl. 2, no. 19, 1849). But Tryon (loc. cit., p. 184) believed the identity of these to be uncertain. He identified Reeve's species as *Sipho kroyeri* Möller and that of Middendorff as *Buccinum striatum* Sowerby (Rec. Gen. Sci., v. 1, pt. 2, p. 134, 1835).

Another name mentioned by Tryon as possibly available is "var. *elatio*" Middendorff (loc. cit., pt. 2, p. 461, pl. 5, f. 2, 1849, and Reise . . . Sibiriens, v. 2, pt. 1, p. 228, pl. 8, f. 1, 1851). I do not have access to either of these works but have obtained the references from Mrs. Nettie MacGinitie (Proc. U. S. Nat. Mus., v. 109, pp. 122-124, 1959) whose testimony I consider to be reliable. Mrs. MacGinitie believes that these two uses of the name by Middendorff apply to forms that are specifically distinct and for them she uses the names *Nep-tunea middendorffiana* MacGinitie (loc. cit.) and *Neptunea heros* Gray (Proc. Zool. Soc. London,

v. 18, pt. 18, pp. 14-15, pl. 7, 1850) respectively. It should be observed that neither Middendorff nor Mrs. MacGinitie referred either of these two species to the genus Buccinum.

Because neither Carpenter (Report Brit. Assn. for 1856, published 1857) nor Sherborn (Index Animalium) took notice of the name elator, the implication is that there was some irregularity in the way in which it was proposed. Reference to Middendorff's work confirms this. Actually, the name has no standing in zoological nomenclature at all for it was proposed in polynomial form. According to Mrs. MacGinitie, the two publications by Middendorff are as follows:

1849. Tritonium (Fusus) antiquum var. communis obsoletior forma elator.

1851. Tritonium (Fusus) antiquum var. communis insignior forma elator.

Inspection reveals a fundamental difference between these polynomials and those of Martini and Chemnitz (Neues Syst. Conchyl. Cab., v. 1-11, 1768-1795) and those of the pre-Linnaean writers, such as Rumphius, Klein, and Adamson. In these, the first word is the genus, the remainder of the polynomial forms a descriptive phrase that does duty as a specific name. This is why the International Commission on Zoological Nomenclature retained the generic names used by Martini and Chemnitz when they suppressed the specific names given by these writers (Opinion 184, v. 3, pp. 25-36, 1944); the generic names were not suppressed until 14 years later (Official Index of Rejected and Invalid Works in Zoological Nomenclature, first installment, p. 5, footnote, 1958). If Middendorff's polynomials had been of the same type, it would be necessary to reject all of his names as published in a work not consistently binomial, which would be most unfortunate, as Middendorff was a careful scholar and most of his names have been accorded the acceptance which they merit. But Middendorff's polynomials are not parallel to those of the other writers; they do not form descriptive phrases but each term represents a successive grade in the process of differentiation of intraspecific forms. Each term is a separate nomenclatorial unit; those which can be interpreted as having the rank of a taxonomic category recognized by the Commission are available for that purpose; those which apply to groups lower in rank have no more standing in zoological nomenclature than the names of the mutations of Drosophila melanogaster and are available to anyone who wishes to validate them.

In this case Tryon validated the name for a variety of Buccinum tenue Gray with evanescent ribs; he credited it to Middendorff although

Middendorff himself used it to designate a variety of Tritonium antiquum, now generally known as Neptunea antiqua but originally described as Murex antiquus Linnaeus (Syst. Nat., Tenth ed., p. 754, no. 486, 1758).

Dall (Proc. U. S. Nat. Mus., v. 9, p. 215, 1886) accepted the name elator in the sense in which Tryon used it but did not describe it. Later (Ibid., v. 56, p. 324, 1919) he described two varieties of Buccinum tenue Gray to which he gave the names rhodium and lyperum. If for any reason the name elator be rejected, the varietal names given by Dall will be next in line, but in that case a new varietal name will be needed for the form which Gray considered typical.

Finally Dall (Bull. U. S. Nat. Mus. 112, p. 97, 1921) accepted the name elator as a variety of Chrysodomus satura Martyn (Figs. Non-descript Shells, table 2, f. 47, 1784). This is in accordance with Middendorff's intention, for Martyn's species is very closely allied to Neptunea antiqua Linnaeus, and it is not impossible that Martyn may have thought them identical. But it is not in accordance with Tryon's idea, since he applied the name to a species that some authorities would place in a different genus, if not even in a different family.

The earliest names in the synonymy of Buccinum tenue Gray are of uncertain meaning, if one can judge by the different interpretations placed upon them by later writers. Whether any one of them is available can be determined only by an examination of the holotypes, and it is not impossible that the holotypes may no longer be in existence. Pending the time when an examination of these species can be made, we must give tentative acceptance to the earliest available name whose application is certain beyond possibility of reasonable doubt. The oldest such name appears to be elator Tryon 1880. The availability of this name is not clouded by the earlier elator of Middendorff since this was not proposed in accordance with the rules.

Dall's use of the name in 1921 appears to be an attempt to do belated justice to Middendorff, but it came too late. Tryon had already validated the name for a different species (and Dall had concurred in the use of the name). The species called Buccinum tenue by Gray must therefore be Buccinum elator Tryon until such time as new evidence to invalidate the use of this name be brought to light.

Since the gender of Buccinum is neuter, the specific name should be used in the neuter form also, which would make the name Buccinum elatus.

A Study of the Reproductive Cycle in the California Acmaeidae (Gastropoda)

Part II

by

HARRY K. FRITCHMAN II

(From the Department of Zoology, University of California, Berkeley, California,
and the Department of Biology, Boise Junior College, Boise, Idaho)

(Plates 15 to 17)

Subgenus NOTOACMAEA IREDALE, 1915

Acmaea persona ESCHSCHOLTZ, 1833

Ecology: — This is a high intertidal limpet which lives as high as or higher than the other high form, *Acmaea digitalis* Eschscholtz, 1833, but is much less eurytopic, never being found below zone 1. It prefers rocky areas which afford it dark crevices and under-surfaces where it can spend the daylight hours since it is a nocturnal form and feeds only at night or on heavily overcast days. It is a scraper of what appear to be bare rock surfaces since little macroscopic algae can live with such minimal exposures to wetting by the sea. Typically its habitat is seldom, if ever, submerged and receives only splash and spray from the surf at high tide. *Acmaea persona* was studied primarily from the rocky point south of Rockaway Beach, San Mateo County, California (37°30'25" N; 122°30'W) where the species occurs in moderate numbers on the highest of the intertidal rocks. Here the animals are found between five and six feet above the zero tide level and extend down to the highest populations of the barnacle, *Balanus glandula* Darwin, 1854. *Acmaea digitalis* is found up to the middle of this range but disappears above that, leaving only the high littorine, *Littorina planaxis* Philippi, 1847, as a frequent co-resident with *A. persona*. This shore is exposed to the full radiation of the sun, and the tops of the rocks are always burned free of any algae, the only plant material present here being the unicellular algae cast up by the surf. Along the bases of the rocks, however, and in shaded crevices there is often a film of algae which may give the rock a greenish sheen.

Collections: — The initial collections of this animal consisted of only a few specimens (usually five or less) every two weeks. Beginning in late August, 1950, the number of these was increased to ten per sample, and this was continued throughout the remainder of the study. The entire investigation extended from November 19, 1949, through April 16, 1952, during which period a total of 459 animals was examined: 127 males, 128 females, and 204 indeterminate. Despite this small sample size, complete reliance can be placed in the data assembled for this species since it shows a simple annual reproductive cycle in which the population participates very much as a unit.

Results: — This species (Plate 15) has a clear-cut annual reproductive cycle which is characterized, at Rockaway Beach, by a single complete spawning during the latter part of March and the first part of April. This spawning may be preceded by a partial spawning earlier in the year as occurred in 1951 and 1952. Such a partial spawning leaves the gonads reduced in turgor but by no means completely spawned, perhaps only one-third to one-half of the gametes having been released. Subsequent to this early partial spawning, the gonad is more or less redeveloped to a ripe condition in which state the complete spawning occurs. This latter spawning is an unusually complete discharge of gametes, the ovary retaining only a few residual eggs and the testis having only small gray patches of sperm remaining. During the succeeding months, May and June, these residual gametes disappear, probably due to breakdown and resorption, so that by mid-June or earlier the entire population has become sexu-

ally indeterminate. It remains in this condition until late October at which time the gonads begin redevelopment and by the last of November all animals are again of determinate sex. The development of the gonad continues until a fully ripe condition is reached at which time either a complete spawning (1950) or a partial spawning (1951 and 1952) occurs. Beginning in January, 1952, and continuing into April, 1952, collections were obtained through the courtesy of Dr. Rudolf Stohler, from several points in Sonoma and Mendocino Counties, California. Data obtained from these samples indicate that Acmaea persona from these more northern areas exhibits essentially the same reproductive cycle as those from the region of San Francisco.

Analysis of Environmental Conditions Coincident with Spawning: —

Plate 15 shows that the redevelopment of the gonad of this species begins in late October and early November. It is at this time that the new gametes become visible in the exposed gonad at moderate magnification. As has been previously indicated, October is a critical month for both air and water temperatures for it is then that the annual decline in temperatures begins. It is interesting to observe the close correspondence between this environmental change and the beginning of regrowth of the gonads.

It would seem probable that a marine animal living high in the intertidal zone, as Acmaea persona does, might spawn during a period characterized by unusually high tides since it would only be under such conditions that the animals would be submerged for any length of time. However, the periods of 1950, 1951, and 1952 for which complete spawnings are recorded do not include any extreme tidal fluctuations. Rather, it is the lack of such extremes which is surprising, the highest tide recorded in the three periods being 5.8 feet in 1951. Nor can the stimulus to spawning be attributed to a particular lunar phase since a new moon was in evidence during the 1950 spawning and full moons during both the 1951 and 1952 periods. An analysis of the two periods in 1951 and 1952 when partial spawnings took place shows that tidal fluctuations here contrast strongly with those associated with the periods of complete spawnings just discussed. In 1951 the period of partial spawning included a tidal range of 8.8 feet, which is about a maximum for the San Francisco coastal area. This range occurred at the beginning of the period on January 7 and was associated with a new moon. Toward the end of the 15-day period, the full moon with its

lower tidal range became prominent. Essentially similar conditions prevailed in 1952 during the period of partial spawning except that here the full moon came at the beginning of the period and the new moon at the end.

The mean temperatures for complete spawning periods of the three years are very similar. That of the water shows a variation of only 1.5° F. (52.0° — 53.5°) throughout the three periods while that of the air varied only 1°F. (50° — 51°). It is perhaps the attainment of such specific environmental temperatures which acts as the stimulus for spawning. During the periods of partial spawning the air and water temperatures were below those of the periods of complete spawning. As has been discussed, the partial spawnings appeared to occur within two to four weeks following the development of fully ripe gonads. It is interesting to note that the time required for this development varies from year to year and thus influences the time of the partial spawning. In 1950 fully ripe animals were not found until mid-February and the spawning which followed was a complete spawning, no partial spawning occurring in this year. By contrast, fully ripe animals were present in December 1950, and a partial spawning took place in late January 1951. An intermediate condition was found in 1952 when fully ripe animals were found in late January and a partial spawning took place in late February.

Table 2 summarizes the temperature conditions for October through February of the years 1949-1950, 1950-1951, and 1951-1952. The winter of 1949-1950 was the coldest of the three winter periods, and it was in this season that gonad redevelopment was slowest and a partial spawning was lacking. The comparable period of 1950-1951 was considerably warmer, and a rapid development of the gonads was observed, together with an early partial spawning. The winter of 1951-1952 was again intermediate, both in conditions of temperature and in gonad redevelopment.

On the basis of the seasons of activity of 1950-1951 and 1951-1952, it is evident that Acmaea persona is reproductively active during the period of October to April. The mean surface water temperatures characterizing these months are listed below, together with the corresponding air temperatures. From these data, then, it is assumed that the single complete spawning of the year occurs at a relatively fixed period and is correlated with the appearance of a particular range of environmental temperatures. It is further suggested that go-

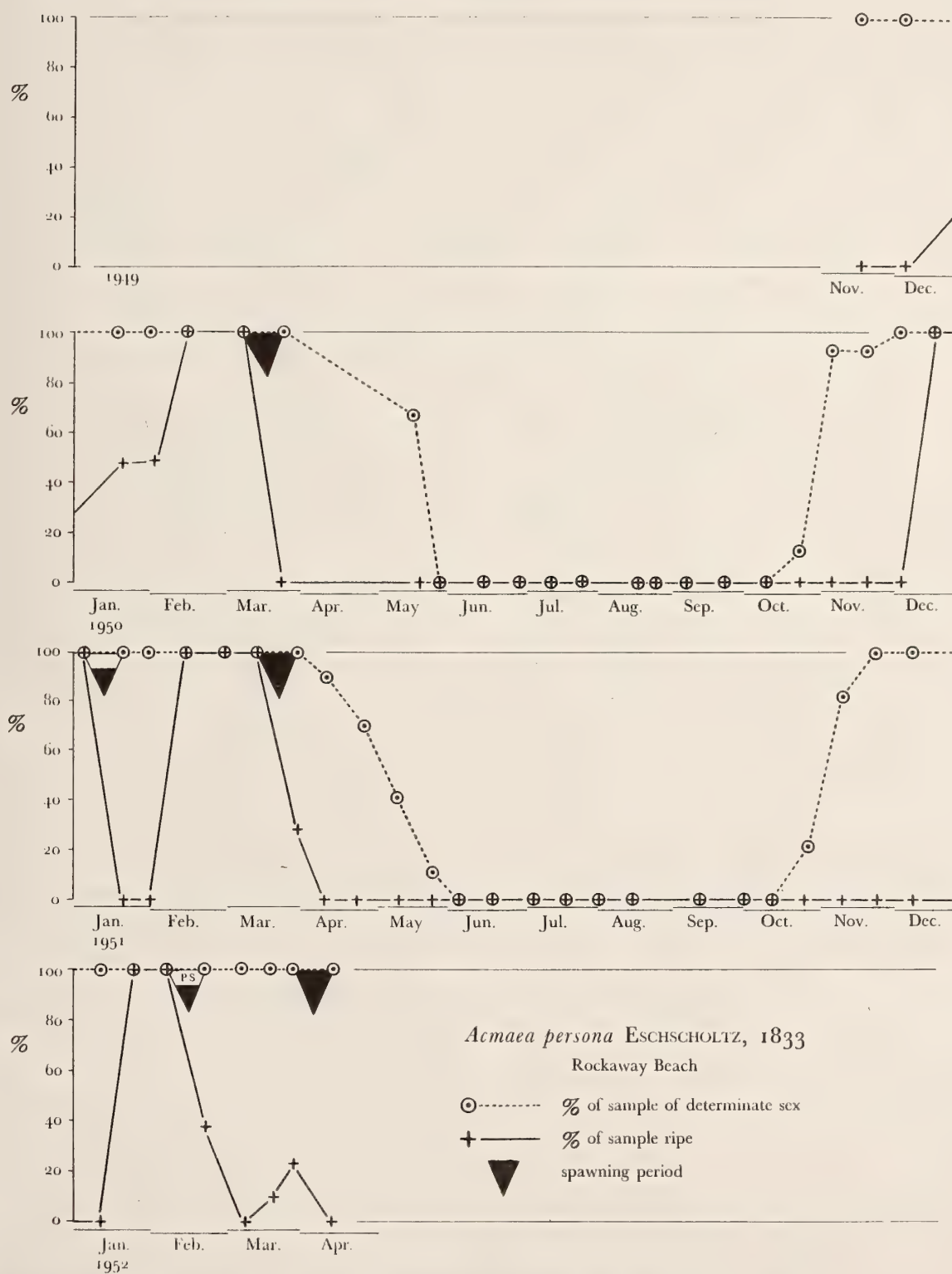


Table 2

Summary of Mean Air and Water Temperatures October through February, 1949 - 1952

	Mean Air Temperature Half Moon Bay			Mean Water Temperature Fort Point		
	1949 - 50	1950 - 51	1951 - 52	1949 - 50	1950 - 51	1951 - 52
October	52.9	57.1	56.1	56.9	58.3	59.1
November	57.9 *	59.3	53.8	54.9	57.5	55.2
December	47.3 *	54.0	49.3	51.5	54.9	52.7
January	44.7 *	49.4	47.3	48.3	50.4	50.4
February	49.7	50.5	50.3	50.0	50.6	52.9
Mean	50.5	54.1	51.6	52.3	54.3	54.1

* Temperatures from Santa Cruz, California (data from Half Moon Bay not available)

nad redevelopment begins shortly after the year's temperature maxima have been passed and that the rate of development thereafter is influenced directly by the temperatures of the winter season. This rate of development determines, in turn, whether or not a partial spawning takes place and the time when it will occur.

	October	April
WATER		
1950-1951	58.3°	52.4°
1951-1952	59.1°	53.8°
AIR		
1950-1951	57.1°	50.7°
1951-1952	56.1°	51.4°

Acmaea fenestrata cribraria CARPENTER, 1857

Ecology: — This species was studied exclusively from the southern point of Rockaway Beach. Here the species is less common than either *Acmaea pelta* Eschscholtz, 1833 or *A. scutum* Eschscholtz, 1833 and occupies an ecologic niche essentially exclusive to itself. It seems to require a substrate of very smooth boulders which do not have macroscopic algae on them. These boulders are typically set in loose gravel and sand, and the animals retreat down the sides of the rocks and are found at low tide grouped in the shaded areas of the boulders with their shells pressed slightly into the gravel. The essential feature of the habitat of this animal at Rockaway Beach is the polished bare rock surface chosen as a substrate. Only rarely is either of the other limpets found in zone 2 or 3 [*A. pelta* or *A. scutum*] observed on these rocks since these two species apparently require the presence of at least some macroscopic algae. From this description it is evident that *A. f. cribraria* is a film feeder and not a browser.

Collections: — This species was studied from a level of about zone 2 where the prevailing algae were *Ulva* and *Petrocelis* or some related encrusting red alga. At this level both *Acmaea scutum* and *A. pelta* were to be found, the former being the more common. The gonad of *A. fenestrata cribraria* does not seem to undergo the extensive growth that is characteristic of *A. persona*. Indeed, the degree of turgor encountered in the *A. fenestrata* gonad is only comparable to that of a partially ripe *A. persona*. Collections were begun on May 5, 1950, and were continued through April 16, 1952, at two-week intervals. Samples consisted of about five animals and a total of 246 limpets was examined: 120 males, 93 females, and 33 indeterminate.

Results: — At the time (Plate 16) that the study was begun, the animals were all in a partially spawned condition. The gonads continued to regress until by June 18, 80 percent of the sample had become indeterminate. Although the two July collections show high percentages of determinate animals, these specimens were all in a spawned condition and did not represent a redevelopment of the gonad. It was not until the collection of August 27 that partially ripe animals were found, and these possessed gonads in the first stages of redevelopment. From this date until November 24, the gonads continued to increase in degree of ripeness until spawning occurred during the last week of November or the first week of December and was continued, probably, to about December 22. Following spawning, a redevelopment was observed until a second spawning occurred during the middle of January. A third and last spawning took place sometime during the last of March, after which the gonads showed a continued regression to the indeterminate condition characteristic of the summer months. There is some

reason to believe that a small spawning took place between the collections made on February 2 and February 18 since the animals found on the earlier date showed at least partially developed gonads while those on the 18th were definitely spawned. The collection of August 18 marked the beginning of gonad regrowth, and this continued at a slow rate through December and early January, the first spawning of 1952 occurring sometime during the last half of January. Between March 10 and 22 a second spawning took place.

Analysis of Environmental Conditions Coincident with Spawning: —

At Rockaway Beach this limpet is reproductively active beginning in late August or early September and continuing until mid-May of the following year. From mid-May until mid-August the animals are reproductively inactive, a large percentage being indeterminate. Approximately a month before the year's temperature maxima are reached the gonads begin to redevelop so that in September all of the animals are of determinate sex and partially ripe. The summer indeterminate period may result from the unfavorable environmental conditions present at that time. The period from May through August is quite warm and is certainly the driest of the year but does not include the warmest month, September. Nor is the beginning nor the end of this phase marked by any striking environmental change. However this may be, the reproductive cycle of *Acmaea fenestrata*, like that of *A. persona*, is marked by an inactive phase during the months when heating and desiccation are near their maxima. *Acmaea fenestrata* can be considered to be reproductively active from August through April or from sea temperature means of the following:

	August	April
1950-1951	60.5°	52.4°
1951-1952	58.0°	53.8°

As has been discussed in relation to *Acmaea persona*, the winter of 1950-1951 was characterized by temperatures somewhat above those of 1951-1952 and the possible relation of this to the rate of gonad redevelopment has been indicated. A similar relationship is seen for *A. fenestrata* since its first spawning occurred in November-December 1950 while the corresponding spawning of 1951-1952 was delayed until January 1952. The effects of tidal activity and lunar phase are impossible to evaluate because of the fact that, except for the spawning of March 18-April 1, 1951, either a new moon

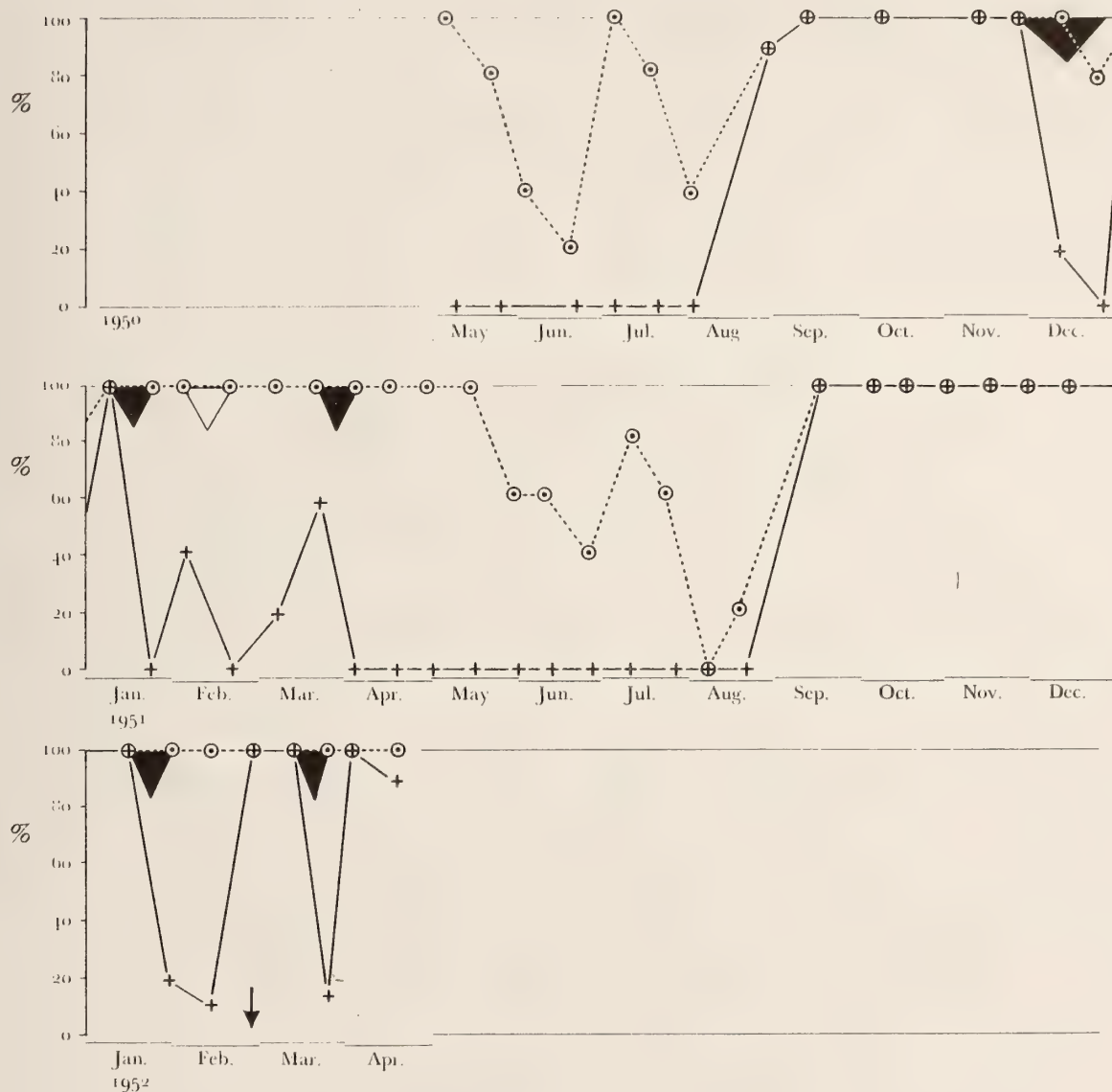
or a full moon was present at the beginning and at the end of the two-week interval between collections. For this reason, it is not known which moon, if either, constituted a stimulus for spawning. This problem will be encountered frequently and is, of course, a result of the necessity of making collections when the tides were favorable for field work. Air and water temperatures seem to bear no relationship to initiation of spawning in this limpet since spawnings are recorded at water temperatures ranging from 50.0°F. to 56.0°F. or over about $\frac{2}{3}$ of the total mean yearly range (51—60°F.). From this study, then, while it has been possible to elucidate the nature of the annual cycle of this limpet at this latitude and to suggest some of the factors which may control it, it has not been possible to analyze successfully the factors which serve as stimuli to spawning.

Acmaea scutum ESCHSCHOLTZ, 1833

Ecology: — This fairly eurytopic species was also studied from the south point of Rockaway Beach where the animals are found in large numbers. As has been stated before, this shore is composed of large boulders set in sand and gravel. At the level of zone 2, where *Acmaea scutum* is most abundant, these boulders have only sparse growths of algae: *Endocladia*, *Ulva*, and in more shaded regions, some *Petrocelis*. In addition to this macroscopic growth, the rocks typically have a greenish sheen caused by a thin film of algae which is also present on the shells of the limpets in somewhat thicker mass. The impression has been gained from this study that *A. scutum* is primarily a scraper of this algal film in contrast to *A. pelta* which seems to require macroscopic algae for food. For this reason, there is a reduced competition between the two species which, at first glance, seem to occupy the same ecologic niche. This does not imply that *A. scutum* will not browse on larger algae if such are present, for it certainly does so in the lower intertidal zones.

Collections: — The first collection of this species was made on September 25, 1949, and collections were continued until April 16, 1952. In all, 1535 animals were examined: 804 males, 684 females, 22 indeterminate, and 25 immature. The sample size was consistently about 25 animals.

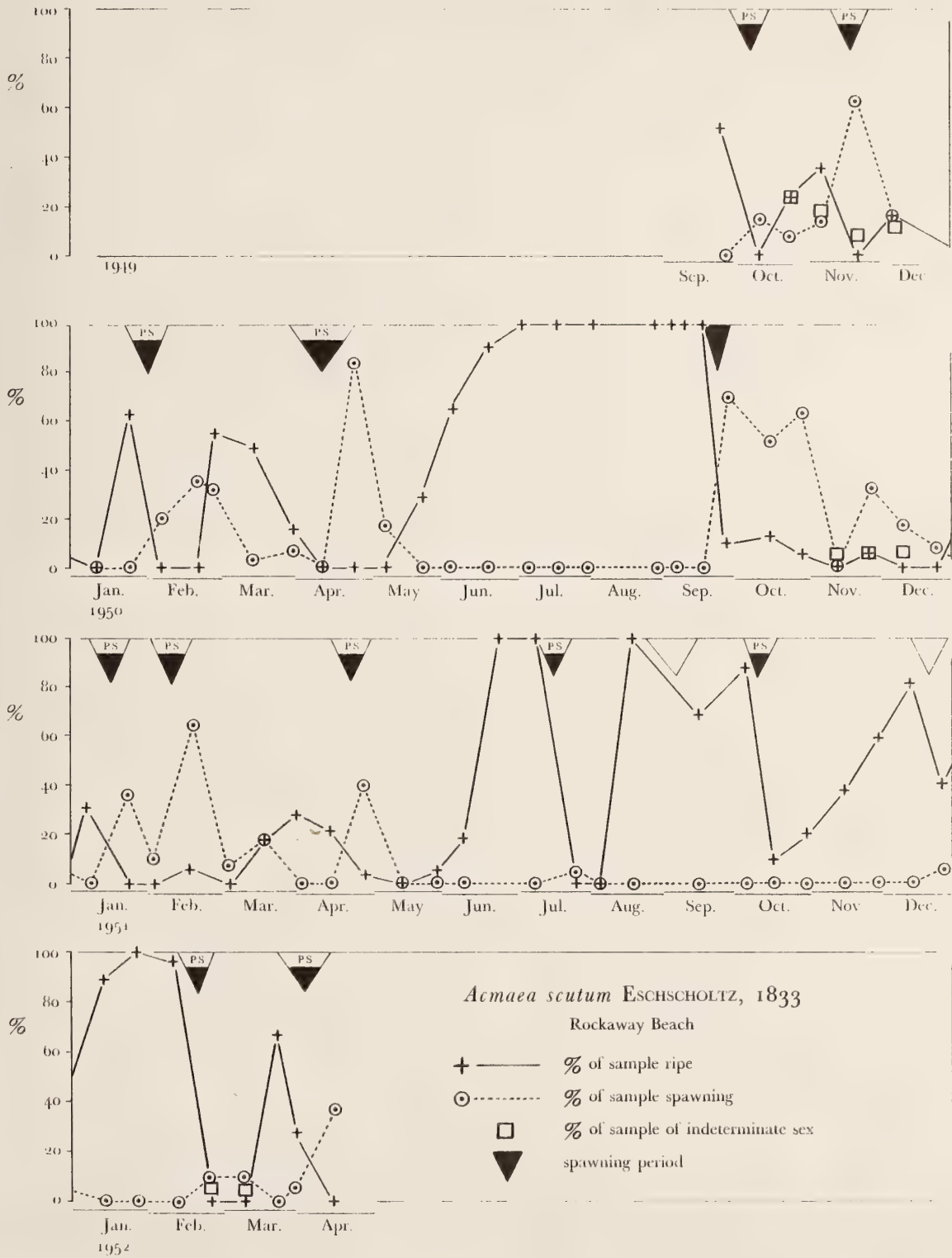
Results: — The reproductive cycle (Plate 17) of this species is characterized by several spawnings throughout the year, most of these being partial spawnings. The animals are reproduc-

*Acmaea fenestrata cribraria*

CARPENTER, 1857

Rockaway Beach

- % of sample of determinate sex
- +----- % of sample ripe or partially ripe
- ▼ spawning period
- ↓ laboratory spawning



tively active throughout the year, no indeterminate summer period being present in this species at this latitude. When indeterminate animals do appear in the samples, they are the result of unusually complete spawnings which render sexing impossible. There does, nevertheless, appear to be a sort of latent period in the summer months during which spawning may be suspended, although the animals may be completely ripe. Such a condition is seen in the summer of 1950 when the entire population was fully ripe from July through September and yet no spawning took place. A somewhat similar situation prevailed in the summer of 1951 when a very light partial spawning occurred in mid-July. Aside from this and an ill defined fluctuation in early September, spawning was suspended from late April to mid-October, essentially as it was in the preceding year. The reproductive potential of this species at this latitude is thus considerably greater than those of its two related species, *Acmaea fenestrata cribraria* and *A. persona*, previously discussed, and its spawning activity is, for the most part, restricted to the fall, winter, and spring months.

Analysis of Environmental Conditions Coincident with Spawning: —

As in the case of *Acmaea fenestrata*, water and air temperatures do not seem to play a dominant rôle in determining spawning time. Spawnings have been recorded over the entire yearly mean temperature range of the water; from 50.5°F. in January 1951 to 61.5°F. in September 1950. There does, however, appear to be a rather fixed time for the first spawning in the fall which is seen to have occurred between the following dates in successive years: September 25-October 9, 1949; September 17-September 26, 1950; and October 3-October 15, 1951. Only in 1949 was the first fall spawning associated with a drop of the water temperature. In 1950 and 1951 these first spawnings took place when the water temperature was at or near the maximum. The effect of tidal fluctuations and moon phases are somewhat obscured because of the several cases where prominent tidal movements occur both at the beginning and at the end of the two-week interval between collections. As with *A. fenestrata*, it is impossible to determine which, if either, of these acted as a stimulus to spawning. However, if these periods are disregarded, there still remain seven periods when a spawning is associated with a full moon: January 1-February 5, 1950; March 28-April 11, 1950; September 17-September 26, 1950; April 15-April 28, 1951; July 8-July 22, 1951; October

3-October 15, 1951; March 31-April 16, 1952. Only one spawning comes at the time of a new moon, April 11-April 23, 1950. On this basis, then, there is some reason to believe that the phase of the full moon, with its attendant tides, may influence spawning of this species.

Acmaea insessa (HINDS, 1842)

Ecology: — This limpet is restricted to the alga *Egregia Menziesii*, a plant with long strap-like stipes which is found attached to rocks in zone 3. The width of the shell of *Acmaea insessa* coincides perfectly with that of the central portion of the algal stipe and it is here that the animals are found. As they move along the stipe, they scrape away and ingest the plant tissue which forms their food. A stipe to which a limpet is clinging is readily identified by the long scar made by the feeding animal. Because of the availability of food and the favorable intertidal environment of zone 3, this is a very hospitable habitat for a limpet. Enmeshed as it is in the fronds of the alga, it is well protected from desiccation during the not infrequent periods of tidal exposure; during high tides the limpet is spared the pounding action of the heavy surf due to the cushioning effect of the pliable alga. However, the absolute size which the animal can attain is probably limited since, as its height increases, it becomes more unstable and may be swept off of the stipe and eliminated.

Collections: — The data for this species are based on the examination of 394 animals of which 187 were males, 204 females, and 3 immature. These were collected from the beds of *Egregia* found in the area locally referred to as the Bath Tub at the north end of Moss Beach, San Mateo County, California (37°31'30"N; 122°31'W). The sample size, when collecting conditions permitted, was regularly ten animals. In addition, approximately 50 more specimens were taken from the rocks at the north end of Asilomar Beach, Pacific Grove, California, where the limpet is quite abundant. During the summers of 1955 and 1956, minor collections were made from the breakwater guarding the entrance to Newport Bay, Orange County, California.

Results: — This highly stenotopic species exhibits a spawning cycle which is made very difficult to interpret because of the tendency of the animals to spawn at almost any provocation. Indeed, it is not uncommon for them to spawn even before they have been returned to the lab-

oratory for examination. It seems that any deviation from the normal conditions associated with their habitat will induce them to spawn. They have been known to spawn in damp collecting jars at any temperature from 10° to 20°C. The sudden shock of adding cold sea water to the jar in which they are attached will often trigger spawning. A standard procedure to get embryological materials has been to set the animals out in separate finger bowls in water at sea temperature and to allow them to warm gradually. Typically, they begin to spawn at about 19° to 20°C. This procedure also indicates that it is not necessary for the animals to be in close contact and that any animal will spawn when completely isolated. This would be expected considering the isolated position of the animals on the algal stipes where it is very rare to find more than one per stipe. That it is not the effect of being removed from the alga which causes the spawning has been shown by collecting the animals attached to a small piece of alga, after which they spawn as readily as if they had been collected in the usual fashion. The only method which has had any success in keeping the animals from spawning spontaneously has been to place them in finger bowls in which there is just sufficient water to cover the shell and then to keep them at sea temperature, 11°C., or somewhat lower. This is not simply a local phenomenon associated with the populations from Moss Beach as has been demonstrated by achieving the same effect from the animals collected from Asilomar Beach and also from Newport Bay. In the total of 42 collections from Moss Beach extending over the period from November 5, 1949, to November 11, 1951, at approximately two-week intervals, spontaneous spawnings in the laboratory have occurred 28 times. The majority of the cases in which spawning did not occur were probably the result of examining the animals on the first or second day after collection, thus avoiding exposing them to the frequent shocks attendant upon increase in temperature when it was necessary to change the water in the collecting jars. Beginning with the collection of August 27, 1950, spawning occurred regularly in each collection. During most of this interval, fecal samples were being taken and the animals were retained in their jars for a week or ten days, thus giving them ample opportunity for spawning.

Analysis of Environmental Conditions Coincident with Spawning: —

Because of the long series of collections from August 27, 1950, to November 28, 1951, when

spawnings took place in the laboratory, it is necessary to search for clues to the stimuli for natural spawning in the ocean in the collections extending from November 5, 1949, to August 26, 1950, during which interval only four samples spawned after collection. The collection of November 5, 1949, coincided perfectly with a full moon and at this time the animals were all partially spawned. As a beginning point it was assumed that the limpets had spawned under the influence of the full moon and its tides. Over the period of the next three collections, November 19, December 4, and January 15, the gonads were redeveloping and in spite of their partially ripe condition, artificial fertilization resulted in the production of normal larvae from the two latter collections. On January 29, 1950, the gonads were all fully ripe but by February 12, 80 percent had spawned. A full moon was present on February 2, just after the collection of January 29. Since the new moon came on February 16, four days after the sample of February 12, it can be assumed that the spawning took place in association with the full moon. From February 26 to April 23 the gonads were considered to be fully ripe although there was a continuous but gradual increase in size and in turgor over this period. The collection made on May 5, 1950, and which followed the full moon of May 2, consisted of only partially spawned or fully spawned limpets. There can be no question here of the non-correspondence of the new moon phase since it occurred on April 17 and prior to the all ripe collection of April 23. Thus a third spawning can be associated with the full moon. A spontaneous spawning of the sample of June 2 took place in the laboratory. Controlled experiments were carried out on the limpets from the next two collections made on June 18 and July 16 by isolating them in finger bowls and allowing the temperature to rise as already described. Of the animals from the June 18 sample, two failed to spawn and two others spawned only slightly. When the unspawned animals were examined, they were found to be ripe; this is taken as an indication that the entire sample was ripe when collected. The sample of July 2 was composed of ripe animals following the full moon of June 29. A similar experiment was made on the July 16 sample during which all ten of the limpets spawned from moderately to very heavily, showing again that this sample was also ripe when collected. The sample of July 29 again contained all partially spawned animals, and the full moon preceded the collection by only one day, being maximal on July 28. This accounts for another spawning coinciding with the full moon. There is a final

bit of evidence which comes from a sample from Asilomar Beach taken on July 17, 1951. Fourteen limpets were taken and isolated as described above, each animal spawning heavily. The gametes were used for embryological work and produced excellent cleavage and larvae. On July 19 two other samples were taken from the same bed of *Egregia*, treated as before, but only a single female spawned and she very slightly. Examination showed that the gonads were all partially or completely spawned. A full, unclouded moon was at its maximum on July 18 at the time that the population is known to have spawned. This seems to substantiate the view that these limpets show a lunar periodicity associated with the full moon.

It is concluded that *Acmaea insessa* spawns at least four, and possibly five, times throughout the year. An alternative view would be that this species spawns regularly with the full moon each month. This theory requires that the animals be able to redevelop their gonads within 28 days after any given spawning date. But this does not seem to be the case as the long, slow redevelopment following the November 5, 1949, spawning indicates. In addition, the long latent period of ripeness seen between March 12, 1950, and April 23, 1950, seems to preclude the possibility of any spawning in this interval, since, as mentioned before, there was a gradual increase in turgor of the gonad during this period, no reduction in size being observed.

Acmaea paleacea GOULD, 1851

Ecology: — This tiny limpet which seldom exceeds a centimeter in length and two to three millimeters in breadth is found exclusively on the marine grass *Phyllospadix*, a plant which is restricted to zone 4 and to permanent tide pools in zone 3. The narrow shell of the limpet fits nicely the equally narrow leaves of the plant, the cortical cells of which form the food of the animal. This is, of course, a very favorable habitat for the limpet since it has an abundance of food and is never subjected to the extremes of heating and desiccation which, in varying degree, are characteristic of the higher zones.

Collections: — The small size of this limpet plus its relatively inaccessible habitat in the lower intertidal made its collection difficult. Samples were thus restricted to ten animals,

the interval between collections being two to four weeks depending on the tide. The samples were taken from the southern point of Rockaway Beach and the study extended from November 19, 1949, to August 27, 1950. The investigation had to be abandoned after the latter date when a sand bar began to accumulate over the bed of *Phyllospadix*. The 163 specimens examined included 85 males and 78 females.

Results: — The analysis of the first three collections is open to question which is always the case when a new population study is begun since there is initially no point of reference. These collections, November 19, December 4, and January 15, all included animals which were interpreted as being partially ripe. However, artificial fertilizations carried out with the two latter collections were successful and normal trochophores were produced. This indicates that mature eggs and sperm were present even though the gonads did not show the high degree of turgor associated with ripeness. Indeed, the small size of the animal makes it almost impossible to examine the gonad without rupturing it when the shell is removed, and criteria of ripeness must be based more upon thickness of the gonad and quantity of gametes present than upon degree of turgor. A ripe gonad in this species is usually $1\frac{1}{2}$ to 2 millimeters thick. During the next three collections, January 29, February 12, and February 19, spawnings occurred in the laboratory resulting in normal trochophores. The collections through March, April, May, and June contained specimens which were considered ripe, and another laboratory spawning occurred in the sample made on June 18. The remaining collections made in July and August were composed of ripe animals. At no time during the study were any typically spawned animals found, and this similarity to that found for *Acmaea insessa* inclines one toward the conclusion that *A. paleacea* may be following a reproductive pattern such as is postulated for *A. insessa*. The continued fullness of the gonads throughout the period studied also tends to support this conclusion. Thus, on the basis of what data are available regarding *A. paleacea*, it is assumed that this species probably is in breeding condition throughout the year and is releasing gametes in response to some regularly and frequently occurring stimulus, perhaps tidal fluctuations associated with the lunar cycle.

Drepaniella mapae gen. et spec. nov.,
a New Goniodoridid Nudibranch from South-Eastern Australia

by

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(Two Textfigures)

The nudibranch family Goniodorididae is poorly represented in Australian waters; until this record the family was represented by two species of *Goniodoris*, both of which are restricted to the south-eastern coastline of Australia. The family is well represented in New Caledonia (Risbec, 1928) and Japan (Baba, 1949) in the Pacific area. The opportunity is here taken to provide a synoptic key to the genera which have at various times been assigned to the Goniodorididae.

DREPANIELLA BURN, gen. nov.

Goniodoridids, without mantle margin or processes, dorsum without cirri or processes. A single bifurcated process present laterally to each rhinophore. A pair of stout extrabranchial processes present. Gills three, bipinnate. Rhinophores large, with strong annular lamellae around them, contractile. Tentacles digitiform, ends slightly swollen and rounded. Foot without tentaculiform anterior corners, anterior margin rounded and bilabiate. Radula and jaws unknown. Genital organs unknown.

Type species: *Drepaniella mapae* spec. nov.

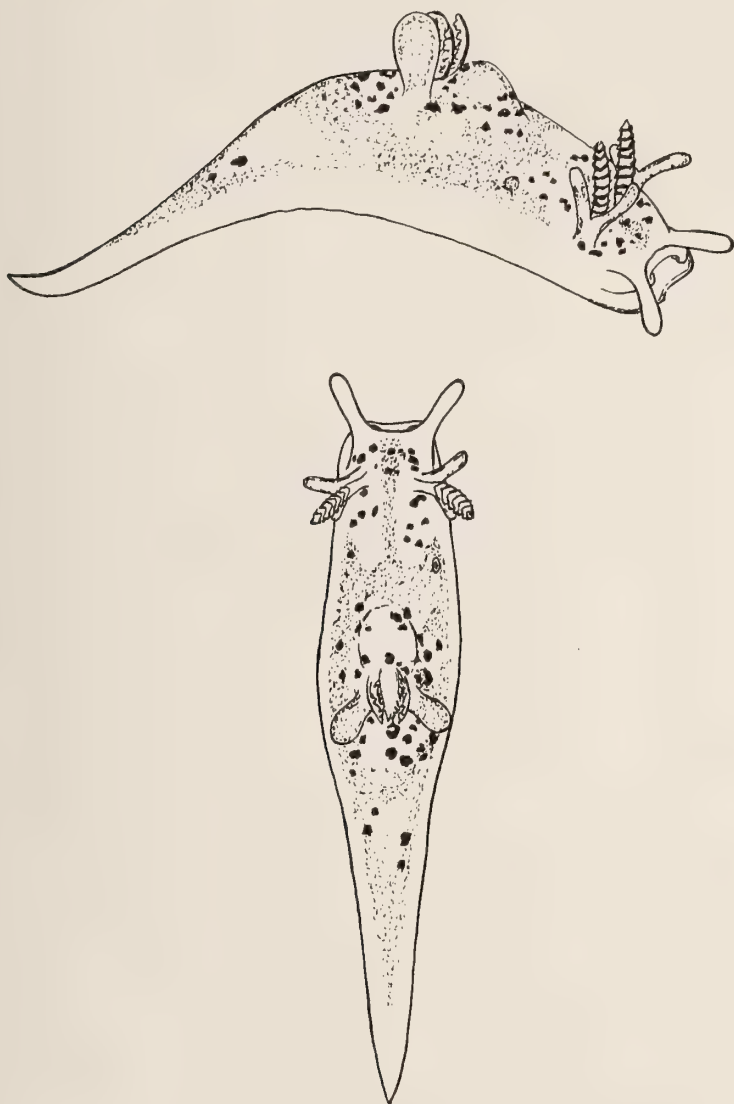
Drepaniella mapae BURN, spec. nov.

The single living slug was 4 mm. long, of this the tail comprised about one-third. Preserved, it measured 1.5 mm. long, 0.7 mm. broad, and 0.9 mm. high. The body is translucent and smooth. The colour is whitish, the tail and margins of the foot are opaque white. A sub-epidermal cream pigment marks the sides of the body; a broad band of the same colour transverses the body in front of and behind the gills,

and there is a narrow median stripe of the colour between the rhinophores. Varying sized dark spots of brown epidermal pigment complete the body colouring; these are mostly spread in front of the gills and rhinophores, behind the gills, and there are one or two spots each side on the tail. In preservative (alcohol), the brown pigment becomes black. In the living slug, the gills were yellowish, the anal area between the gills yellow, and the rhinophores were whitish with opaque lamellae.

The body is slender and humped, being highest at the pericardial prominence just in front of the gills. The foot is narrower than the body. The tentacles are digitiform, the ends slightly swollen and rounded. The rhinophores are large, triangular in section with a flat face to the front; there are seven strong lamellae on each, these are more prominent behind than in front. The rhinophoral processes at the anteriolateral base of each rhinophore is stout at its base but bifurcated into two slender distally-swollen arms at about midlength; the processes are about half as long as the rhinophores. The three gills are bipinnate, the central one is the largest and has 6 or 7 rounded pinnules each side of the rhachis. The extrabranchial process, one each side just posterior to the level of the lateral gills, are stoutly digitiform with rounded ends and narrow bases. The anterior edge of the foot is bilabiate and curves up like a crescent towards the mouth. A very thick-edged shallow veil or ledge is present below and between the tentacles; on each side this terminates in a minute lobiform knob.

The genital pore is about one-third the rhinophore-gill distance behind the rhinophores. The male duct is visible in the living slug as a shining cream hair-line disappearing into the body; it gives the impression of being cuticularized or armed for this part.



Drepaniella mapae BURN, gen. et spec. nov.

Figure 1: Animal seen from Right Side

Figure 2: Animal seen from Dorsal Side
magnification 24 x

The eyes are visible deep within the body just behind the rhinophores, where they appear to be sessile upon the central nervous system. They are black in colour.

The radula, jaws and genital organs have not been examined in the only available slug.

Occurrence: The single specimen was collected just south of Point Danger, Torquay, Victoria, Australia (long. 144° 19' 15" East, lat. 38° 20' 45" South). It was seen crawling on the green

alga *Caulerpa* in a large rock pool at low tide; collected by the writer, October 23, 1960.

Holotype: The one and only specimen has been deposited in the National Museum of Victoria, Melbourne, Australia, no. F21'273.

Discussion: This minute species at present cannot be confused with any known Australian species of Nudibranchia. *Drepaniella mapae* can be differentiated from all the known species of the family Goniadorididae by either the rounded instead of tentaculiform foot corners or the bifurcated rhinophoral processes instead of styliform ones. In particular, these two characteristics of the new genus separate it from *Trapania* Pruvot-Fol (1931, p. 309), the genus to which the writer thinks the new genus approaches closest. As indicated in the key of Goniadoridid genera, *Trapania* has both tentaculiform foot corners and rhinophoral processes but the latter are simple. *Ancula* Lovén (1846) has a pair of rhinophoral processes to each rhinophore but they arise separately from the body and not from a common trunk as in *Drepaniella*. Certain Goniadoridids such as *Hopkinsia* MacFarland (1905) and *Okenia* Menke (1830) have dorsal cirri, others have a mantle brim (*Goniadoris* Forbes and Goodsir, 1839) while a third group have this mantle brim replaced by a number of processes (*Ancula* Lovén, 1846). In each and every case tentacles are present on the head. Nine genera are here considered to belong to the Goniadorididae, and these are tabulated below in a key to the family.

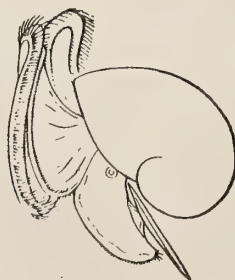
1. Sole of foot broad, anterior corners tentaculiform. Mantle brim present. Radular formula 1.1.0.1.1
 . . . *Goniadoris* Forbes and Goodsir 1839
1. Sole of foot narrow 2
2. Dorsum without cirri or processes . . . 3
2. Dorsum with cirri and papillae . . . 6
3. Foot corners tentaculiform 4

3. Foot corners rounded. With one bifurcated process at the base of each rhinophore and one process each side of the gills. Radular formula unknown
 *Drepaniella* Burn gen. nov.
4. Without rhinophoral and extrabranchial processes. Radular formula 2.1.0.1.2
 *Spahria* Risbec 1928
4. With rhinophoral and extrabranchial processes 5
5. With two processes at the base of each rhinophore and a number of processes beside the gills. Radular formula 1.1.1.1.1. . . .
 *Ancula* Lovèn 1846
5. With one process at the base of each rhinophore and one process each side of the gills. Radular formula 1.0.1.
 *Trapania* Pruvot-Fol 1931
6. With one or two cirri at the base of each rhinophore and one or two large cirri in the median line in front of the gills. Radular formula 1.1.0.1.1. . . . *Okenia* Menke 1830
6. As above but without rhinophoral and pre-gill cirri. Radular formula 3.1.0.1.3. . .
 *Bermudella* Odhner 1941
6. Without rhinophoral processes. Radular formula 1.1.0.1.1. 7
7. Cirri spread sparsely over dorsum and along mantle brim. Cirri present in semicircle in front of gills
 *Hopkinsiella* Baba (vide 1949)
7. Cirri densely spread over dorsum and along mantle brim
 *Hopkinsia* MacFarland 1905

The new generic name is derived from the preoccupied *Drepania* Lafont (1874) which was replaced by *Trapania* Pruvot-Fol (1931). The specific name comes from the monogram of Miss Margaret A. Pilbeam, of Torquay, Victoria, who was present with the writer when the species was collected.

Literature Cited

- Baba, K.
 1949. Opisthobranchia of Sagami Bay collected by His Majesty the Emperor of Japan. 194+7 pp. 50 pl. Tokyo.
- Bergh, R.
 1881. Beiträge zu einer Monographie der Polyceraden. II. Verh. Zool. Bot. Ges. Wien., 30 (1880), pp. 629-668, pl. 10-15.
- Lafont, A.
 1874. Description d'un nouveau genre de nudibranches des côtes de la France. J. Conchyliol., Vol. 22, No. 3, pp. 369-370. (Not seen)
- MacFarland, F. M.
 1905. A preliminary account of the Doridiidae of Monterey Bay, California. Proc. Biol. Soc. Washington, Vol. 18, pp. 35-54.
- Marcus, E.
 1957. On Opisthobranchia from Brazil. J. Linn. Soc. Lond., Zool., Vol. 43, No. 292, pp. 390-486.
- Odhner, N. H.
 1939. Opisthobranchiate Mollusca from the western and northern coasts of Norway. K. Norske Vidensk. Selsk. Skr., 1939, No. 1, 93 pp., 59 figs.
- _____, _____
 1941. New Polycerid Nudibranchiate Mollusca and remarks on this family. Göteborg. K. Vet. Vitterh.-Samh. Handl., F. 6, (B), 1(11), pp. 1-20.
- Pruvot-Fol, A.
 1931. Notes de systématique sur les Opisthobranches. Bull. Mus. Hist. Nat. Paris (2), 3, pp. 308-316.
- Risbec, J.
 1928. Contribution à l'étude des Nudibranches néo-Calédoniens. Faune Colon. Franç. (A. Gruvel), 2(1), pp. 1-238, pl. A-D, 1-12.



Vexillum utravis (MELVILL, 1925) Trawled in Philippine Waters

by

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(Plate 18 and One Textfigure)

During the summer of 1960 several specimens of an unknown *Mitra* species were sent to me by Fernando Dayrit of Manila. Although superficially similar to *Vexillum caffrum* (Linnaeus, 1758), *Vexillum melongena* Lamarck, 1811, and others, and incorrectly identified under these names in several collections I have examined, it differs from these species in several respects and it was impossible to feel satisfied with such an identification. Recently I came across the original description and figures of a species which I believe pertain to this shell; namely, *Mitra* (*Vexillum*) *utravis* (Melvill, 1925). I repeat the original description here, and offer the accompanying plate and discussion in the hope that it may help other collectors who have been puzzled by this species. To the best of my knowledge, nothing has been published on *V. utravis* subsequent to the original description which appeared in the Proceedings of the Malacological Society of London in 1925; those who do not have access to this publication may find the following discussion useful.

The specimens sent me by Mr. Dayrit were brought up in otter trawls from a mud bottom, in from 20 to 40 fathoms in Carigara and Maqueda Bays, Philippine Islands (see map). The fishing trawlers from Manila work this area frequently because it is particularly rich in shrimp and bottom-feeding fishes which they obtain for the market. Other gastropod species brought up in the same area by the trawl nets include: *Tibia fusus* (Linnaeus, 1758); *T. powisi* (Petit, 1842); *Cypraea pulchella* Swainson, 1823; *Turris speciosa* (Reeve, 1843); *Epitonium scalare* (Linnaeus, 1758); *Volva volva* (Linnaeus, 1758); *Conus alabaster* Reeve, 1849; *C. sulcatus* Bruguière, 1792; *C. radiatus* Gmelin, 1791; *C. sowerbyi* Reeve, 1849; *C. insculptus* Kiener, 1850; and others.

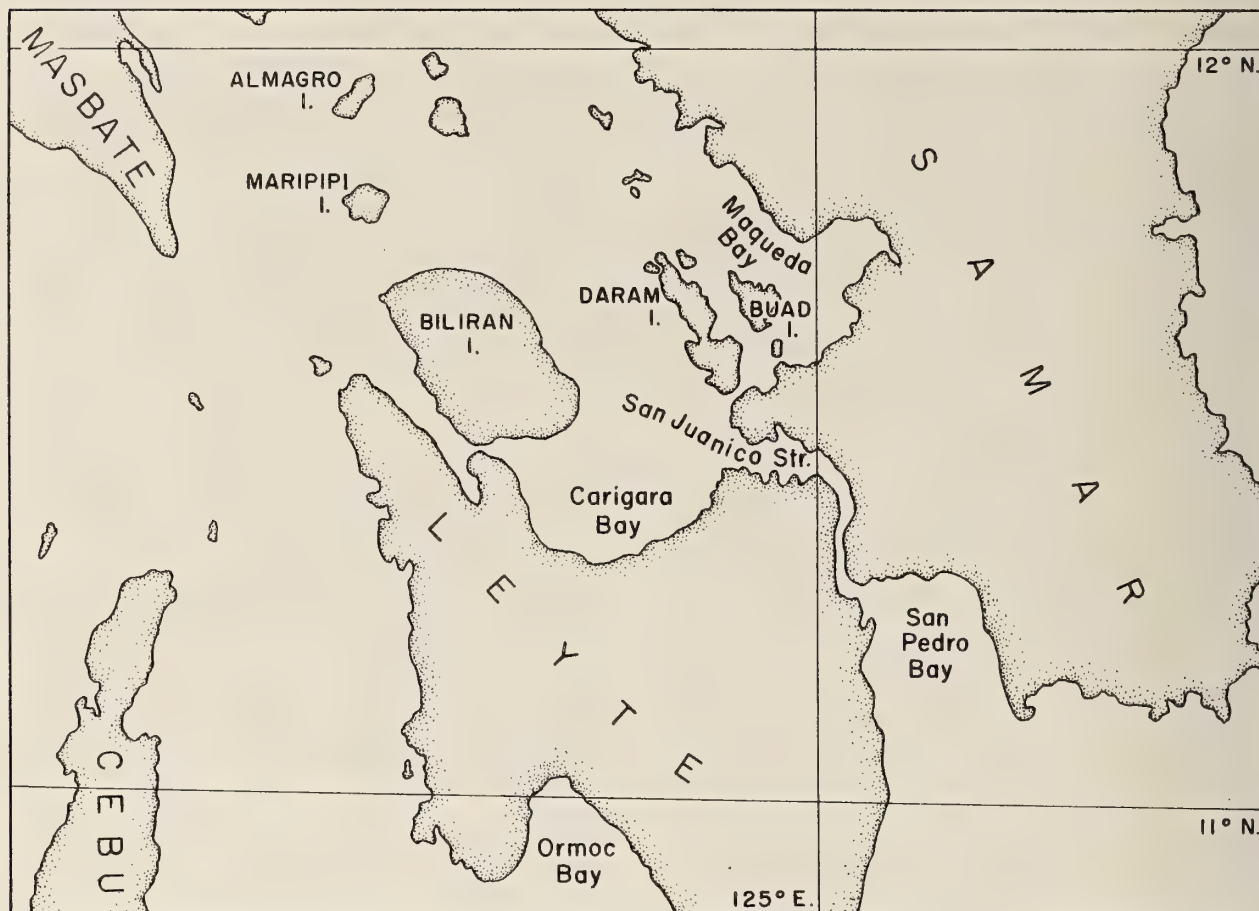
Melvill's original description of *Vexillum utravis* is as follows:

"*Mitra* (*Vulpecula*) *utravis*, n. sp.

Shell biconical-fusiform, somewhat shining, dark chestnut brown, whorls eight, all, excepting the nuclear, very closely longitudinally ribbed, but these are evanescent on the dorsal surface of the body-whorl, which is therefore quite plain and smooth. The upper-whorls are spirally once white banded just above the sutures, the body-whorl possesses two such bands, one at the periphery, the other half-way between it and the base, this being narrower, and not so distinct. The ribs are sharp, and clearly defined, slightly flexuous, suturally impressed, interstices closely sulcate, aperture pale grey, outer lip only slightly thickened, columellar margin four-plicate canal recurved basally. Long. 30. Lat. 10 mm. Hab. ---?

This is a puzzling species, and may be a hybrid between *M. caffra*, L., and *M. melongena*, Lam. There are likewise some points of resemblance with *M. formosensis* Sowb., but that much larger species (Long. 50, Diam. 16 mm.) is noted for its deep sutural impressions, and very rounded whorls, while the longitudinal ribs are, as in the case with our new species, obsolete on the dorsal surface of the body-whorl."

It will be noted that Melvill placed his species in the subgenus *Vulpecula* Blainville, 1824; this subgenus is presently regarded as a synonym of *Vexillum* Röding, 1798. I do not recognize this specific name (*utravis*) as an adjective and I therefore do not change its form when combining it with the currently accepted generic name of neuter gender.



Textfigure 1: Type Locality of *Vexillum utravis* (MELVILL, 1925) - Carigara Bay, Samar Sea, Philippine Islands

Melvill apparently formulated the name *utra-vis* (meaning "either one or the other") with a tongue-in-cheek attitude; as seen in his quoted discussion of the species he also recognized its affinity for *Vexillum cafrum* and *V. melongena*. It is also possible the name stemmed from the fact that the species is either ribbed or smooth, depending on the aspect in view.

One important character was omitted in the otherwise adequate description of *Vexillum utravis*: that is the presence of several fairly prominent lirations inside the lip. A second photograph of the same specimen is shown here (Plate 18, fig. 3) in which these lirations may be clearly seen.

The specimens sent to me by Mr. Dayrit agree favorably in size with Melvill's measurements of the holotype; in a series of seven specimens, the smallest measures 28.6 mm., the largest 39.0 mm. A small degree of variation in relative width can be seen in the series, one

or two individuals being slightly more ventricose than the average; however, this is still well within the normal limits of variation among the Mitridae. The measurements of the present series are as follows:

Length	Width
(in Millimeters)	
28.6	9.3
30.5	10.7
32.6	10.2
34.1	10.6
36.7	10.8
36.9	10.5
39.0	10.9

Vexillum utravis differs from *V. cafrum* (Linnaeus, 1758) chiefly in that the ventral surface of the body whorl is ribbed, the dorsal surface smooth; in *V. cafrum* the entire body whorl is smooth, sometimes the penultimate



Figure 1



Figure 2



Figure 3

Dorsal and Ventral Aspects of *Vexillum utravis* (MELVILL, 1925)

Figures 1 and 2: Normal View of Shells
Figure 3: View Showing Lirations Within Lip

whorl is smooth as well. The early whorls are entirely ribbed in both species.

Vexillum melongena (Lamarck, 1811), also frequently mistaken for V. utravis because of a basic similarity in color and markings, is a coarser, heavier species with correspondingly coarser sculpture throughout. The shoulders are angulated in V. melongena, rounded in V. utravis; the sides in V. melongena are straight, rounded in V. utravis; and finally, the canal is much more recurved and attenuated in V. utravis than in either of the other species.

Since the collecting locality of the holotype was unknown and therefore not indicated by Melvill in describing the species, the type locality of Vexillum utravis (Melvill, 1925) is hereby designated as Carigara Bay, Philippine Islands (11°35' N. Lat., 124°40' E. Long.).

Acknowledgment

The accompanying map of the type locality area was provided through the courtesy of Mr. Dayrit, whom I wish to thank further for his unfailing helpfulness and generosity. My deep appreciation goes also to Dr. Rudolf Stohler, Dr. Myra Keen, and others who helped untangle the unusual problem in nomenclature involved with this species. The photograph is by Pierson, Oswald and Pierson.

Literature Cited

- Melvill, James Cosmo
1925. Descriptions of nine new species of Mitridae. Proc. Mal. Soc. Lond., Vol. 16, p. 218, Pl. 10, figs. 8, 8a.

Description of a New Hawaiian Subspecies of *Cypraea tigris* (LINNAEUS, 1758)

by

CRAWFORD N. CATE

Conchological Club of Southern California, Los Angeles 7, California

(Plate 19)

Since the publication of my article, "Redescription of *Cypraea tigris lyncichroa* Melvill, 1888" in the January 1, 1961 *Veliger*, it has come to my attention through the kindness of Dr. F. A. Schilder that the use of this name is invalid as applied to the Hawaiian subspecies. The type of *C. tigris lyncichroa* was mentioned by Hugh C. Fulton in an article in the *Journal of Conchology*, 1929, as follows:

"*Cypraea tigris* var. *lyncichroa* Melvill.
Type. Long. 80. Diam. 58 mm.

Note — this is simply a small heavy broad shell with markings having some slight resemblance to *C. lynx*. The type has a small patch of pale golden brown colour on its dorsum, a character that occurs occasionally in many varieties of the species."

Unfortunately, I overlooked this reference in preparing the above-mentioned article. It had been my hope to avoid complicating the literature with additional names applied to an established species, but according to Dr. Schilder's letter (February 1961), the somewhat sketchy article by Fulton constitutes a valid redescription of Melvill's holotype. This species differs from the Hawaiian race in several ways; therefore my application of the name *lyncichroa* to the Hawaiian subspecies makes it a stillborn homonym, necessitating the emendation of my former article and the renaming of the subspecies as it occurs in the Hawaiian Islands.

Dr. Schilder's letter states:

"I have seen, before the World War II, Mel-

vill's holotype in the collection of the late J. R. le Brockton Tomlin, a very good friend of mine; it is only 80 mm. long, callous, more fulvous than white, with small dorsal spots and the marginal callus reaching far up; such heavy shells seem to occur chiefly in the smallest islands of Micronesia and Southern Polynesia, therefore I

used the name lyncichroa for designation of the Pacific race."

This more extensive description of the holotype by Dr. Schilder points out that the most obvious differences between the typical Cypraea tigris lyncichroa and the Hawaiian race are as follows:

Comparison Between Two Subspecies of *Cypraea tigris* LINNAEUS, 1758

	<i>Cypraea tigris lyncichroa</i>	<i>Cypraea tigris schilderiana</i>
1. Size:	80 mm. long, 58 mm. wide	126 mm. long, 87.7 mm. wide
2. Marginal Callus:	heavy, reaching far up	lacking
3. Color:	more fulvous than white	more white than fulvous
4. Weight:	heavy, small shell	relatively light, large shell

Genus: *Cypraea* LINNAEUS, 1758

Subgenus: *Cypraea* LINNAEUS, 1758

Species: *tigris* LINNAEUS, 1758

Cypraea tigris schilderiana CATE, subspec. nov.

Shell large, heavy, pyriformly ovate, acutely humped dorsally, bulbously inflated, posteriorly umbilicate; margins not obviously thickened, sides a continuous symmetrical curve from dorsum to base; extremities somewhat produced; base and lip sloping inward to denticles; aperture wide, straight, curving sharply left posteriorly; neither labial nor columellar teeth extend onto base. Labial teeth strong, wide, flattened, short; interstices deeply channeled, rounded; columellar teeth longer, finer, thickening pointedly on columellar ridge and extending unbroken across fossula; fossula broad, increasingly concave anteriorly; terminal ridges hardly oblique; primary shell surface white or light beige, thickly covered with brownish-black spots which are superimposed upon larger blue spots formed in an earlier stage of development; base and teeth pure white; an orange-brown mantle line traverses the length of the right dorsum.

Cypraea tigris schilderiana (Plate 19, figs. 1 and 2) differs morphologically from *C. tigris tigris* Linnaeus, 1758, by its larger size and heavier shell, its larger and stronger teeth, its wider and straighter aperture, its broader and deeper fossula, and the almost total absence of

lateral thickening or marginal callus. *C. tigris lyncichroa* Melvill, 1888, of the central Pacific is a smaller, more stunted, more heavily calloused form.

Morphological variation among the paratypes of *Cypraea tigris schilderiana* is negligible. Except for a variation in size, the diagnostic characters mentioned in the description of the holotype hold reasonably true among all eleven specimens included in this study.

The type locality here designated for *Cypraea tigris schilderiana* is Koko Head, Oahu, Hawaii (21° 15' N. Lat., 157° 43' W. Long.) with a probable range extending throughout the entire chain of eight Hawaiian Islands.

The holotype has been deposited in the type collection of the Bernice P. Bishop Museum, Honolulu, Hawaii, where it bears the catalog number 212'885. Paratypes will be distributed as follows:

Paratype No. 2, U. S. National Museum, Washington, D. C.

Paratype No. 4, Collection of Dr. F. A. Schilder, Halle, Germany

Paratype No. 5, British Museum (Natural History), London, England

Paratype No. 7, Museum of Comparative Zoology, Cambridge, Massachusetts

Paratypes No. 1, 3, 6, 7, 8, and 10 are at present in the author's collection.



Figure 1

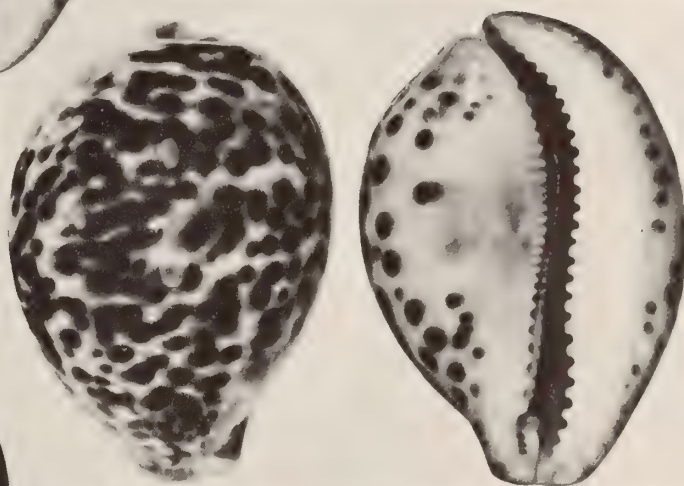


Figure 2

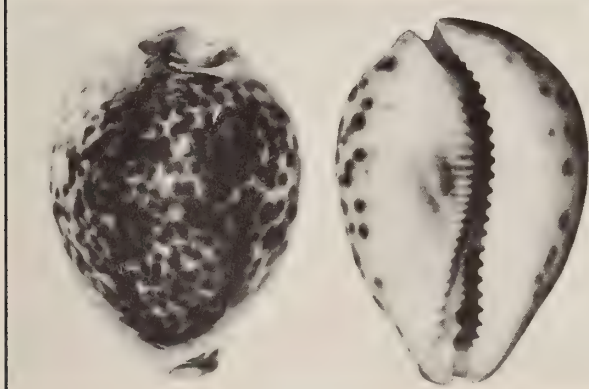


Figure 3

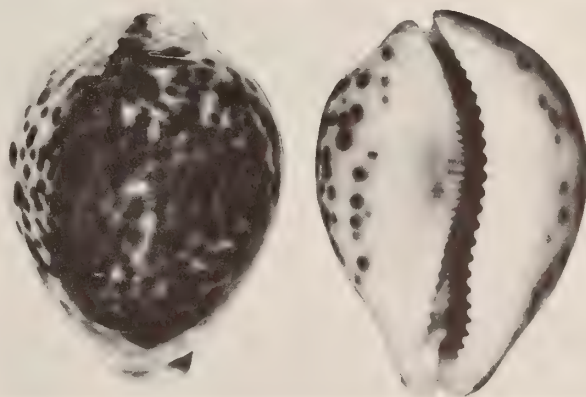


Figure 4

Dorsal and Ventral Aspects of
Cypraea tigris schilderiana CATE, new subspecies,
and *Cypraea tigris* LINNAEUS, 1758

Figure 1: Holotype, *Cypraea tigris schilderiana*
Figure 2: Paratype No. 3, *Cypraea tigris schilderiana*
Figures 3 and 4: Typical *Cypraea tigris*

Measurements and Collecting Data of the Holotype and Paratypes of
Cypraea tigris schilderiana CATE, subsp. nov.

	Length	Width	Height	Depth	Location	Substrate
	(in Millimeters)			(in Feet)		
Holotype:	126.1	87.7	73.1	48	Koko Head, Oahu	lava
Paratype 1:	131.5	91.3	74.0	40	Waikiki, Oahu	lava
Paratype 2:	129.7	86.6	69.5	45	Koko Head, Oahu	coral and lava
Paratype 3:	124.0	84.8	68.2	40	Koko Head, Oahu	ceiling of volcanic ledge
Paratype 4:	124.0	88.1	71.0	35	Nanakuli, Oahu	lava shelf
Paratype 5:	120.0	85.5	67.8	35	Koko Head, Oahu	lava
Paratype 6:	115.5	79.1	69.0	35	Makua, Oahu	lava and coral
Paratype 7:	113.9	80.7	63.9	40	Makua, Oahu	coral slab
Paratype 8:	109.8	71.7	58.3	8	Keei, Hawaii	in an open coral pocket
Paratype 9:	108.1	74.0	59.5	30	Waialua Bay, Oahu	on lava ledge at sand pocket
Paratype 10:	106.8	71.0	59.8	35	Maunaloa Bay, Oahu	just off reef in coral and lava rubble

Acknowledgment

It gives me pleasure to name this new Hawaiian subspecies for Dr. F. A. Schilder, who called to my attention the need for this emendation. I also wish to thank Dr. Rudolf Stohler for his suggestions and encouragement in its preparation, and one other whose help and devotion are indispensable.

Literature Cited

Cate, Crawford N.

1961. Redescription of *Cypraea tigris lyncichroa* Melvill, 1888. *The Veliger*, Vol. 3, No. 3, pp. 66-69, Pl. 11.

Fulton, Hugh C.

1928. Notes on some varieties of *Cypraea tigris* Linné, and *Cypraea vinosa* Gmelin, *Journal of Conchology*, Vol. 18, No. 10, p. 290.

Notes & News

An Unusual Antarctic Chiton

by

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Through the courtesy of Dr. Rudolf Stohler of the University of California I have had the opportunity to study three specimens of a small reddish chiton from Antarctica. These have been identified as *Tonicina zschau* (Pfeffer, 1886), which was described originally from South Georgia Island in the Falkland Group. It has also been reported by Thiele from Booth-Wandel Island. The present material comes

from:

Melchior Island, Antarctica. Two specimens in alcohol collected by M. Neushul, 13 February 1958.

Almirante Brown, Palmer Peninsula, Antarctica. A single specimen now in alcohol but valves in poor condition from initial preservation in formalin, collected by M. Neushul at 50 feet depth, 13 February 1958.

Both of the Melchior specimens are well preserved. One measures 12.3 mm. in length and 4.8 mm. in width. The other, somewhat curled, is about the same size. According to Thiele (1909, page 19) the slit formula of *Tonicina zschau* is 14:1:11. As a check, the curled specimen was partly disarticulated by removing valves i, ii, and viii. These show slits numbering 14 in the head valve, one on each side of valve ii, and eight in the tail valve, or a slit formula of 14:1:8. The difference in the number of slits in the tail valve of Thiele's figured spe-

cimen and the one from Melchior Island may be well within the range of individual variation in the species.

The slits are more or less rectangular in shape and rather deep for the size of the valves. Well defined slit-rays converge from the base of the slits to the valve apices, these being especially prominent on the inside of the head valve. The teeth between the slits are only moderately sharp and are smooth.

Ventrally, the valves are rose-colored except for the small insertion plates and sutural laminae, and except also for the teeth themselves from their margins to the depth of the slits, which are whitish. Eave tissue is quite spongy. In the Palmer Peninsula specimen, because of the method of initial preservation, what appear to be microaesthetes show up in profusion in the dissolved tegmentum under a magnification of X 90.

The girdle of specimens from Melchior Island is uniquely decorated with a narrow band of extremely minute, black, scale-like processes that contrast markedly with the beige coloration of the remainder of the girdle, a feature best seen with some magnification. In the Palmer Peninsula specimen this band is wider, with the black dots less concentrated and more dispersed over almost the entire girdle. The groove in the girdle, illustrated in cross-section by Bergenhayn (1937, fig. 1), shows up well in this specimen, as also do the minute, delicate, pointed spicules widely scattered over the girdle near its margin.

Gills extend almost the entire length of the foot and number about 19 on each side in the curled specimen from Melchior Island. In the one from the Palmer Peninsula, however, the gill count is about 24.

Pilsbry (1893, p. 205) rightly questioned his placement of *Tonicina zschau* in the genus *Tonicia*, which is characterized by the presence of small, black eye-dots (megalaesthetes) on the tegmentum surface of the valves. No such eye-dots occur on any of the three specimens at hand. The present assignment of the genus *Tonicina* to the family Ischnochitonidae (Smith, 1960, p. 166) seems proper, as well as its relationship close to the northeastern Pacific genus *Tonicella*, small specimens of which it resembles superficially except for being longer in relation to width.

Tonicina zschau is the type species of the genus *Tonicina* Thiele, 1906. It is beautifully figured, enlarged and in color, by Bergenhayn (1937, fig. 2). Although but few specimens are reported to have been collected, it is suspected that the species is not at all rare at moderate depths. The present material extends the range of the species to the Antarctic continent proper, well within the limit of drift ice.

Literature Cited

- Bergenhayn, J. R. M.
 1937. Antarktische und Subantarktische Polyplacophoren. Det Norske Videnskaps-Academi i Oslo. Scient. Res. Norwegian Antarctic Exped. 1927-1928 et sqq., instituted and financed by Consul Lars Christensen, No. 17, pp. 1-12, figs. 1-3 in color.
 Pfeffer, Georg [Johann]
 1886. Die Krebse von Süd-Georgien nach der Ausbeute der Deutschen Station 1882-1883. Jahr. Hamb. Wiss. Anst. 4, p. 105, taf. 3, fig. 2. (Quoted from Bergenhayn, 1937)
 Pilsbry, Henry A.
 1893. Polyplacophora (Chitons). (In Tryon's Manual of Conchology, vol. 14, pp. 204-205, pl. 40, fig. 12. Philadelphia. February 25.
 Smith, Allyn G.
 1960. Amphineura. Treatise on Invertebrate Paleontology, Pt. I, Mollusca 1, p. 158. Geol. Soc. Am. and Univ. Kansas Press. August 20.
 Thiele, Johannes
 1906. Note sur les Chitons de l'Expedition Antarctique du Dr. Charcot. Bull. Mus. d'Hist. Nat., vol. 12, pp. 549-550. Paris.
 ————
 1909. Die Antarktische und Subantarktische Chitonen. Deutsche Südpolar-Expedition, 1901-1903, Bd. 10, Zoologie, Bd. 2, Heft 1, no. 2, pp. 18-20, 22, pl. I, figs. 37-47.
 ————
 1928. III. Beziehungen zwischen arktischen und antarktischen Loricaten, Gastropoden, Scaphopoden, und Bivalven. Fauna Arctica, Bd. 5, Lief. 2, p. 628. Jena (Gustav Fischer). August 3.
 ————
 1931. Classis Loricata. Handb. syst. Weichtierkunde, vol. 1, p. 19. Jena.

The Fresh Water Clam *Pisidium ultramontanum* PRIME in Modoc County, California

by

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(Publication Authorized by the Director

U. S. Geological Survey)

The distribution of the freshwater clam *Pisidium ultramontanum* Prime, 1865, is local and discontinuous. It is known living only in northern California and south-central Oregon, and as a fossil as far east as southeastern Idaho (Taylor, 1960). In California the only previously known localities are Eagle Lake, Lassen County; Hat Creek, Shasta County; and the Klamath River at Hornbrook, Siskiyou County.

Thanks to Dr. S. S. Berry of Redlands, California, I am able to record a fourth locality in California for *Pisidium ultramontanum*. Four paired valves, 78 right valves, and 71 left valves (S. S. Berry collection 11'153) of this species were collected two feet below the surface at the north side of Tule Lake Concentration Camp opposite the highway, at Newell, Modoc County, by Hatsume Kosaki in August, 1943. A few shells are worn and broken, but most are as well preserved as Recent specimens, except that they lack the periostracum. Probably, therefore, they are of Pleistocene age.

All the shells from Newell have the characteristic ridges on the beaks, which continue as conspicuous ribs on the rest of the shell. The ribs persist onto the center of the disc and often to the margin of the adult shell. Variation in outline and sculpture in these shells is similar to that in a series of Recent specimens from the outlet of Klamath Lake, Klamath County, Oregon (U. S. Geological Survey collection), with which they have been compared.

Study of the distribution of *Pisidium ultramontanum* revealed (Taylor, l. c.) that it is related to a pattern shared with other mollusks and fishes. This pattern is shaped roughly like a fishhook, which extends from Utah Lake, Utah, northward to southern Idaho; westward down the Snake River Valley and across eastern Oregon to Klamath Lake; and thence southward through Eagle Lake, California, and Walker Lake, Nevada. The occurrence in Modoc

County of *P. ultramontanum* also lies on this course.

Literature Cited

Taylor, D. W.

1960. Distribution of the freshwater clam *Pisidium ultramontanum*, a zoogeographic inquiry. Am. Jour. Sci., V. 258-A, pp. 325-344, pl. 1.

Range Extension for *Cypraea (Luria) isabellamexicana* STEARNS, 1893

by

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Cypraea isabellamexicana Stearns has only recently been reported as an inhabitant of the Gulf of California with two reports of specimens being taken at LaPaz, Baja California (Keen, 1959; Burch, 1959).

This report concerns three living specimens taken at Saladita Bay near Guaymas, Sonora, Mexico, August 24, 1960. The first specimen was taken by my son David, aged twelve, from under a rock while diving about five to seven feet below the surface. A few minutes later two additional shells were found in the same area under a single rock by Mark Rogers of Hesperia, California, also a member of the Conchological Club of Southern California.

To my knowledge this is the first report of this handsome species being taken from the mainland within the Gulf of California.

Other related species taken in this little bay include *Cypraea albuginosa*, *C. annettae*, *C. arabicola*, *C. cervinetta*, *Trivia solandri*, and *Jenneria pustulata*.

Saladita Bay is a small cove reached by a very poor road that leads south from the Cortes

Hotel. It is approximately one and a half miles east of Punta Colorada.

Literature Cited

Keen, Myra

1959-1960. Some range extensions for Pan-
amic Province mollusca. Min. Conch.
Club So. Calif. No. 194: 19, 19A. (Dec.
to Jan.).

Burch, Rose

1959-1960. Comments on *Cypraea isabel-
la-mexicana* Stearns. Ibid. No. 194: 20
(Dec.-Jan.)

Range Extension for *Terebra ornata* GRAY, 1834

by

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On September 6, 1959, Dr. Donald Shasky, Dr. Albert Martin, and I left Puerto Peñasco, Sonora, Mexico, by boat for Saint George Island. The main objective was to dredge the area immediately surrounding the island. Soon after leaving Puerto Peñasco we encountered large ground swells, and due to the small size of the boat we considered it wiser to return. Before turning around we lowered the dredge to sample the bottom. The location was approximately four miles southeast of Puerto Peñasco in 60 to 80 feet of water. The single haul contained one live 88 mm. X 19 mm. specimen of *Terebra ornata* Gray, 1834, several living *Oliva polypasta* Duclos, 1833, and one *Strombina dorsata* (Sowerby, 1832), among a number of other shells.

This is the first report of *Terebra ornata* Gray, 1834, from a collecting station as far north as Puerto Peñasco. The type locality for this shell as listed in Myra Keen's "Sea Shells of Tropical West America," is Panama (seemingly confined to that area). In Reeve's Conchologia Iconica the habitat is given as the Galapagos Islands. Dr. Shasky and I have obtained *T. ornata* Gray, 1834, from the shrimp trawlers in

Guaymas, and several specimens were taken off Espiritu Santo Island, Gulf of California, in 80 fathoms on the Ariel Expedition in August of 1960.

Terebra ornata Gray, 1834, can be expected throughout the Gulf of California and southward to Panama and the Galapagos Islands.

Haliotids and Stomatellids from Swain's Reef, Queensland

by

ROBERT R. TALAMADGE

Willow Creek, California

Recently, several lots of Archaeogastropoda were received for identification and comparison. As the collecting station was "new" to the writer, and as several of the lots presented some interesting distributional data, it was thought that a few brief notes might be of general interest. All of the specimens were taken on Swain's Reef, about 200 miles off the Queensland Coast of Australia (Lat. 21°00'30" S.; Long. 152°E. approx.).

Family: STOMATHIDAE

Stomatella varia (A. Adams)

The lot consisted of a single specimen that, except for size (10 mm.), fits into other sets of the species from various localities in the far western Pacific. The specimen was larger than Easter Island material and smaller than Melanesian and Micronesian lots. However, as only a single specimen was available, such comparisons have little or no value. A larger series is needed to establish if a definite cline exists.

Stomatolina sanguinea (A. Adams)

Again, only a single specimen was available. In size, shape, and sculpturing, the specimen matched the typical species. However, in coloration this specimen fits into the Tuamotu Archipelago series. That is, the coloration is pink to rose, rather than the usual scarlet or white with dark maculations. As no mention was noted in Cotton's paper on the Archaeogastropoda, this may be a new record for this species in Australian waters.

Family: HALIOTIDAE

Haliotis ovina Gmelin

Several specimens, indistinguishable from any other lot, were in the shipment. There was nothing noted to separate this population of the species from lots collected over the general range.

(?) Haliotis crebisculpta Sowerby

Two examples of what the writer refers to as this species were present. A very similar shell, perhaps a geographical race at the most, has been noted from the Capricorn Group and the Keppel Islands, both off the Queensland Coast. Some have identified these as H. dissona Iredale, while others have referred to them as a new and undescribed species. The Swain's Reef specimens in coloration were a rusty red, with few maculations, compared to other Australian lots, which are red with strong maculations of green and gray. The New Caledonian specimens examined were gray-green with red or rusty maculations. The two shells were less lamellose than Australian specimens, yet were more highly sculptured than the New Caledonian specimens. In other words, they appear to be an intermediate cline between two populations, except for coloration. As Swain's Reef is well offshore and closer to New Caledonia than the two other known localities, such an intermediate cline could be expected.

SAN DIEGO

The new Club formed in San Diego in November, 1960, elected the following officers at its regular meeting in January, 1961: John Souder, President; David L. Leighton, Vice-President; Mrs. Kay Webb (730 Date Avenue, Chula Vista), Secretary-Treasurer. Meetings are held on the second Thursday of each month, starting at 7:30 p.m. The Junior Naturalists room of the Museum of Natural History in Balboa Park is headquarters for the Club, which had 64 enrolled members as of February 9, 1961.

Information Desk

What's the Difference?

by

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In the course of a few years a variety of manuscripts and letters pass across an editor's desk. Many interesting problems come along with these, some serious and some not so serious. Sometimes it is quite apparent that the more or less un-careful use of the English language intrudes into the writing of persons who know better, and they are thus misled into expressing themselves inaccurately or even into making a completely incorrect statement. We propose to bring up, from time to time, such points which seem to cause embarrassment or even worse. For today we pick, at random, a pair of words: type and typical.

The word "type" in taxonomic literature is used to designate the (usually unique) specimen upon which a species or subspecies is founded, the specimen which served as the "model" for the author when describing the new taxon. There are, of course, a number of different "types", such as holotype, paratype, etc. A future article in this column will deal with these. The word "type" in essentially the same sense is also used in combinations, such as type species, type genus, type locality. The type specimen, as already implied, is the one specimen which was before the author at the time he described his new species or other taxon. A type species is that species upon which a genus is founded and, similarly, the type genus is the basis for the family. The type locality is that geographical location from which the type specimen was collected. According to the rules of the International Committee on Nomenclature no one can ever change the type specimen, the type species, the type genus or the type locality as originally established. It is true, the type specimen may be assigned to a wrong genus or the same species may have been validly described previously and thus the new description with the new name becomes invalid, but the type specimen remains

valid, no matter what may happen. In many instances the original type specimen became lost — what has to be done in that case will be discussed later. In earlier days particularly, new species were described without knowledge of the place where the type specimen was collected. If at a later date the same species is again found alive, it is then the prerogative of the first person aware of the fact that no original type locality is known, to designate a type locality on the basis of the new find.

The word typical is used correctly in taxonomic writing only to refer to matters which are like the "type". It is never to be used as a synonym for type. In fact, it is conceivable that the type specimen may not be typical for the species but be actually one of possibly many extreme variants. This applies especially to type localities. As pointed out, the type locality is the geographical location whence the type specimen comes. This location may be at the very extreme of the range of a species, where only a rare representative may be picked up. The typical location would be about in the middle of the total range of distribution of the species. But the literature is full of type localities which are not typical. It is not permissible to change the "type locality" of a species simply because the typical locality is elsewhere. The only situation under which a "type locality" may ever be changed would be one where it can be shown conclusively that the original designation of the type locality was in error and that the type specimen indeed came from a locality different from the one originally stated. Such situations did actually arise in some of the earlier expeditions when bottles may have become mixed up during a long voyage and the describer, who most likely was not on the voyage, had to rely on the information supplied him. We have, for example, Hawaiian species of mollusks described as from California, just as there are species collected in the Azores listed with "California" as type locality (or "Habitat" as it was called in earlier years).



Methods & Techniques

A Method for Collecting Limpets, Slippershells and Similar Forms

by

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While shore collecting at San Luis Gonzaga Bay, Baja California, a few years ago I found an exceptionally well preserved specimen of Crucibulum scutellatum attached to a rock estimated to weigh five to ten pounds.

After unsuccessfully attempting to remove the shell I placed the rock in my collecting bag, but it wasn't long until the extra weight was more than I wanted to continue to carry. It then occurred to me that perhaps the shell would move if given the proper stimulus, so after inverting the rock I held the shell in the flame of a match. After the fifth match the animal did move and was easily detached from the rock.

More recently, while on a collecting trip to Puertocitos, Baja California, with Dr. Bruce Campbell, I had an opportunity to try a modification of the "heat" treatment.

Dr. Campbell carries a small propane cylinder in his repair kit for use as a soldering torch. When the flame of this was gently directed at several species of small limpets the steam generated between the animal and the shell literally blew the shell off, leaving the animal still attached to the rock. Examination failed to reveal damage to the shell.

This method is especially helpful in removing shells nestled in depressions or crevices in the rocks.



Books-Periodicals-Pamphlets

INDO-PACIFIC MOLLUSCA:

Monographs of the marine mollusks of the Tropical Western Pacific and Indian Oceans.

R. Tucker Abbott, editor. Published by the Department of Mollusks, Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania. Subscription price, \$5.00 per hundred pages (quarto sized, 8½" X 11").

The first 14 pages of this series summarize the plan of issuance of parts and give a skeletal classification that serves as a guide to the ultimate contents and that can be used for filing the sections systematically, if desired. Thus far, two monographs have appeared:

Vol. 1, no. 1, "The Family *Vasidae* in the Indo-Pacific", by R. Tucker Abbott (pp. 15-32, 10 pls., 3 in. color, March 31, 1959). This covers the genera *Vasum* and *Tudicla*. Good illustrations and descriptions set a high standard for future monographs. Distribution of species is graphically shown on maps, keys are given to aid in identification of species, and line drawings add details on radular features and anatomy.

Vol. 1, no. 2, "The Genus *Strombus* in the Indo-Pacific", by R. Tucker Abbott (pp. 33-146, pls. 11-117, 5 in. color, three of these full-page, November 23, 1960). Not only does this paper give comprehensive treatment for all the Indo-Pacific strombs — both fossil and living — but all other living species of the world are cited in a systematic list. The introductory paragraphs on the Western Pacific Arc and the Origin of the Indo-Pacific Fauna trace something of the past history of the strombids, vigorous survivors of a long-lived gastropod stock. Maps show, for each species, the distribution pattern and also the separation of any geographic variants. The text describes both the shell and the soft parts, insofar as possible, and available data are given on range, habitat, and dimensions. Names are documented in a synonymy of standard form, with statement of type locality and repositories of type material. There is a short bibliography and a two-page index. Each species discussed is illustrated either on good half-tone plates or in color (some by both methods). The color plates are especially fine; rarely can large shells be shown at reduced size without considerable loss

of detail, yet here the color patterns come out distinctly. This is the type of monograph that will need little revision in the years to come. Such added notes as may later prove necessary can be written in on the blank spaces conveniently provided between parts. For those users who bind their copies loose-leaf, new pages can be inserted at these points.

With the continuance of such monographs as these, the identification of Indo-Pacific mollusks should, in a few years, become a pleasure instead of (as at present) a chore.

MK

ON THE QUESTION OF QUANTITATIVE DISTRIBUTION OF THE BOTTOM FAUNA IN THE CENTRAL PART OF THE PACIFIC OCEAN

by Dr. Zenaida A. Filatova
Trudy (Transactions) Instituta Okeanologii, vol. XLI, 1960, pp. 85-97, 2 text figs. (In Russian)

AGS

A QUANTITATIVE DISTRIBUTION OF BIVALVE MOLLUSKS IN THE FAR EASTERN SEAS OF THE USSR AND IN THE WESTERN PART OF THE PACIFIC

by Dr. Zenaida A. Filatova
Trudy (Transactions) Instituta Okeanologii, vol. XLI, 1960, pp. 132-145, 3 text figs. (distributional maps). (In Russian)

AGS

MUSCHELN-EIN WEGWEISER ZU UNGEAHNTEN SAMMLERFREUDEN

by Elsy Thoni-Vogt
Published by Paul Haupt, Bern, Switzerland, 1960, 174 pp., \$9.00. Represented in the United States by John Q. Burch, Los Angeles.

This is a well bound book, treating species of unusual interest and beauty, and illustrated with many remarkably fine black-and-white photographic plates. It would be a valuable contribution other than the language barrier; the text is in the German language.

JQB

SYMPOSIUM ON EDIBLE MOLLUSKS

Proc. Malacological Soc. London, vol.

34, pt. 3, pp. 113-156, Dec. 1960.

1. The ecology and mode of life of the edible mollusc, by G. D. Waugh;
2. The ecology of the molluscan enemies of the edible mollusc, by D. A. Hancock;
3. Some economic aspects of the fisheries for mollusks in England and Wales, by A. C. Simpson.

Although the emphasis in this symposium is on British forms, some tables in part 2 cite Pacific records of gastropod predators and their mode of feeding.

MK

 BIVALVE MOLLUSKS OF THE
FAR EASTERN SEAS OF THE USSR
(ORDER DYSODONTA)

O. A. Scarlato. Keys to the Fauna of the USSR published by the Zoological Institute of the Academy of Sciences of the USSR (Academy of Sciences of the USSR Press, Moscow, Leningrad), 71, pp. 1-150, pls. 1-17, figs. 1-61 in text, 1960. (In Russian)

This paper is arranged under the general categories of historical review (pp. 7-16), morphology (pp. 16-39), distribution (pp. 39-51), systematics (pp. 59-127). It contains discussions and illustrations of 45 species and subspecies of dysodont pelecypods from the northwestern Pacific region along the Russian coast from Bering Sea to northern Japan. These forms are arranged in five families: Mytilidae (9 genera, 2 subgenera, 24 species, 4 subspecies); Pectinidae (4 genera, 3 subgenera, 12 species, 1 subspecies); Limidae (1 genus, 2 species); Anomiidae (1 genus, 1 species); Ostreidae (1 genus, 1 subgenus, 1 species).

Two genera in the Mytilidae are attributed to "Bartsch, 1940 ms." These are: Arvella, type Mytilus faba Müller; and Vilasina, type Vilasina pillula Bartsch.

New species and subspecies described are: Crenella decussata laticostata Scarlato, new subspecies; Arvella manshurica Bartsch ms.; Vilasina pillula Bartsch ms.; Musculus (Musculus) minutus Scarlato, new species; Musculus (Musculus) incurvatus Scarlato, new species; Polynemamussium uschakovi Scarlato, new species.

West American species were reported from Russian waters by Scarlato as follows: Crenella decussata Montagu, C. leana Dall, C. columbiana Dall; Vilasina vernicosa Middendorff; Modiolus modiolus Linnaeus, M. phenax Dall; Musculus nigra Gray, M. olivaceus Dall, M. impressus Dall, M. corrugatus Stimpson, M. seminudus Dall; Adula californiensis Philippi; Mytilus edulis Linnaeus; Delectopecten randolphi Dall; Polynemamussium alaskensis Dall, P. davidsoni Dall; Chlamys islandicus Müller, C. beringianus Middendorff, C. albidus Dall, C. strategus Dall, C. hindsi Carpenter, Limatula subauriculata Montagu; Pododesmus macro-schisma Deshayes.

LGH

 THE OPERCULUM
AND MODE OF LIFE
OF HYOLITHES

by Ellis L. Yochelson

Journal of Paleontology, vol. 35, January 1961, pp. 152-161, pl. 33-34, text fig. 1.

NOTES ON THE CLASS CONICONCHIA

by Ellis L. Yochelson

Journal of Paleontology, vol. 35, January 1961, pp. 162-167.

Hyolithes, a widely known fossil mollusk commonly considered to be an early Paleozoic ancestor to modern pteropod gastropods, is carefully redescribed and its interesting morphology reinterpreted in these two papers. Yochelson believes Hyolithes to have been a virtually sessile, benthonic organism which did not swim but which used a pair of curved arms to prop open the operculum to which they are attached. The class Coniconchia Liashenko, 1957, includes both Hyolithes and Tentaculites, another Paleozoic fossil commonly called a pteropod. In the second paper the author supports Liashenko's classification but suggests that the two groups should eventually be further split into two classes.

ECA



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THE VELIGER is open to original papers pertaining to any problem concerned with mollusks from the Pacific Region.

This is meant to make facilities available for publication of articles from a wide field of endeavor. Papers dealing with ecological, morphological, anatomical, physiological, distributional, taxonomic, etc. aspects of marine, fresh water or terrestrial mollusks from any region bordering on or situated within the Pacific Ocean, will be considered. Even topics only indirectly concerned with mollusks may be acceptable.

It is the editorial policy to preserve the individualistic writing style of the author; therefore any editorial changes in a manuscript will be submitted to the author for his approval, before going to press.

Short articles containing descriptions of new species or lesser taxa will be given preferential treatment in the speed of publication provided that arrangements have been made by the author for depositing the holotype with a recognized public Museum. Museum numbers of the type specimens must be included in the manuscript. Type localities must be defined as accurately as possible, with geographical longitudes and latitudes added.

Short original papers, not exceeding 500 words, will be published in the column "NOTES & NEWS"; in this column will also appear notices of meetings of the American Malacological Union, as well as news items which are deemed of interest to our subscribers in general. Articles on "METHODS & TECHNIQUES" will be considered for publication in another column, provided that the information is complete and techniques and methods are capable of duplication by anyone carefully following the description given. Such articles should be mainly original and deal with collecting, preparing, maintaining, studying, photographing, etc., of mollusks or other invertebrates. A third column, entitled "INFORMATION DESK," will contain articles dealing with any problem pertaining to collecting, identifying, etc., in short, problems encountered by our readers. In contrast to other contributions, articles in this column do not necessarily contain new and original materials. Questions to the editor, which can be answered in this column, are invited. The column "BOOKS, PERIODICALS, PAMPHLETS" will attempt to bring reviews of new publications to the attention of our readers. Also, new timely articles may be listed by title only, if this is deemed expedient.

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